MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

VOL. LXXVI. JUNE 9, 1916. No. 8

Professor R. A. Sampson, M.A., D.Sc., F.R.S., PRESIDENT, in the Chair.

John George Lincoln, Lyndale, Ryden's Road, Walton-on-Thames, Surrey, and 222 Strand, W.C.; and
The Hon. Kathleen Robson, 26 Eaton Square, S.W.,
were balloted for and duly elected Fellows of the Society.

Dr. Henry Norris Russell, F.R.A.S., Princeton, New Jersey, U.S.A.; and
Professor Elis Strömgren, The Observatory, Copenhagen, Denmark,
were balloted for and duly elected Associates of the Society.

The following candidates were proposed for election as Fellows of the Society, the names of the proposers from personal knowledge being appended:—
Edward Lindsay Ince, M.A., B.Sc., Trinity College, Cambridge (proposed by A. S. Eddington); and
John Cromwell Prior, Solicitor, Rosedene, Hayling Island (proposed by W. Goodacre).

Forty-six presents were announced as having been received since the last Meeting, including, amongst others:—
Astrographic Chart: 26 Charts from the Bordeaux, Paris, and Toulouse Observatories, presented by the French Minister of Public Instruction.

On the Identity of Fraunhofer's Group G in the Solar Spectrum with the Hydrocarbon Band 4314. *Preliminary Note.* By H. F. Newall, F. E. Baxandall, A.R.C.Sc., and C. P. Butler, A.R.C.Sc. (Plate 12.)

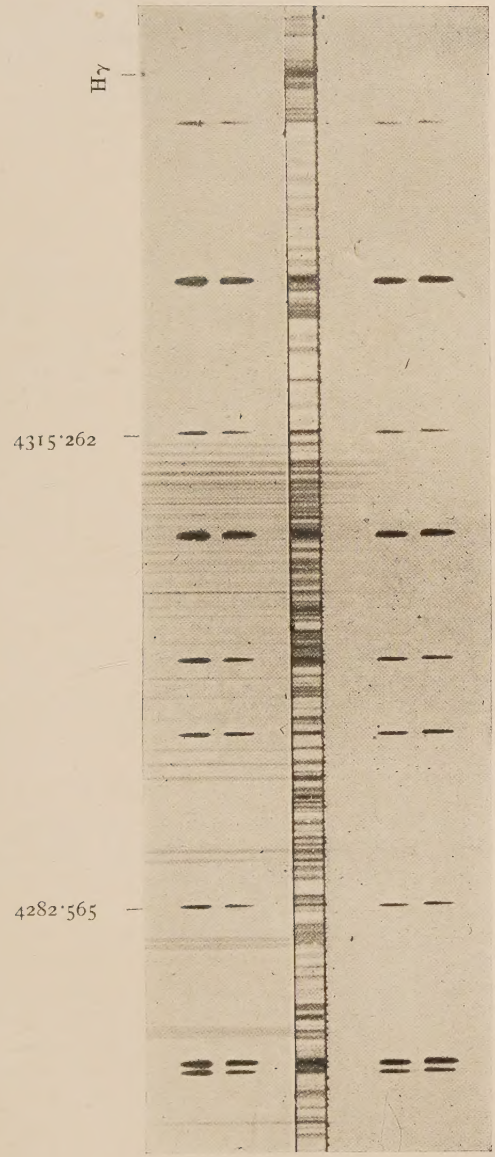
Conclusive evidence has just been obtained that the well-known group of lines, marked by Fraunhofer with the letter G, in the solar spectrum is in the main due to the substance which gives the well-known violet band in the candle-flame spectrum (Swan's Spectrum)—at wave-length 4314—and is generally described as "hydrocarbon."

Great interest is attached to this band for many reasons. There has been a great conflict of opinion as to its true origin in terrestrial sources. The marked presence of the band as an absorption band in the ordinary solar spectrum, and its equally marked absence as an emission band in the spectrum of the chromosphere, as disclosed in total eclipses of the sun, are facts that are of great significance in the interpretation of the solar spectrum. The gradual changes in the intensity of the band in successive types of stellar spectra, should likewise be of great significance in the interpretation of stellar spectra, and of their relation to one another in regard to our views of celestial evolution.

This interest seems to justify the publication of a preliminary note, which shall make known to astronomers not only that the identity of Fraunhofer's group G with the hydrocarbon band has been established, but also that work is being carried on at the Solar Physics Observatory on the many points of interest connected with it.

The subject has been under investigation at intervals by one of us (H. F. N.) at Cambridge for several years, but the claims of administrative business have stood in the way of the completion of proof. The discovery that the envelope of green flame at the base of a Meker burner shows the hydrocarbon bands with surprising brilliancy was made in January 1910, and was noted as the right mode of entry on the experimental verification to be employed when opportunity offered. In 1914, just at the moment when the desired opportunity presented itself, the probable identity was brought forward independently by another of us (F. E. B.). The experimental attainment of the desired proof has been carried out with the help of the third of us (C. P. B.).

The accompanying Plate, 12, is reproduced from two superposed photographs : one (the central strip) is a positive copy of the solar spectrum (exposure 2 seconds) ; the other is a negative copy of the hydrocarbon band of the Meker burner (exposure 12 hours) with four superposed spectra of an iron arc (exposures 2 seconds each). The relative setting of the two photographs is not quite exact, the solar spectrum being slightly displaced



THE HYDROCARBON BAND 4314 IN THE SOLAR SPECTRUM.

towards the red. The faint hydrocarbon lines at 4323-4 can barely be seen, and the still fainter lines towards the red are not detectable on the plate.

Solar Physics Observatory,
Cambridge:
1916 *June* 8.

The Poles of the Planetary Orbits. By J. B. Dale, M.A.

1. Professor H. C. Plummer has recently * called attention to the remarkable fact that the poles of the orbits of the major planets lie three by three on five lines. This, however, is not the only interesting feature which an examination of the diagram of the poles discloses.

On measuring the inclinations of the five lines to the line drawn from the pole of the ecliptic in the direction 315° we find the following values for the angles:—

(1) Earth–Mars–Mercury, . . $3° = 82° - 79°$.
(2) Earth–Uranus–Venus, . . $31° = 82° - 51°$.
(3) Uranus–Jupiter–Saturn, . . $82° = 82°$
(4) Mars–Jupiter–Neptune, . . $136° = 82° + 54°$.
(5) Mercury–Venus–Saturn, . . $161° = 82° + 79°$.

This shows that the lines (2) and (4) are inclined to (3) at nearly equal angles, and so also are (1) and (5).

Now the mean of 51° and 54°, $52\frac{1}{2}°$ stands to 79° in the ratio of 2 to 3, so that the directions of the five lines can be expressed very closely by the formulae

$$\alpha,\ \alpha \pm 2\beta,\ \alpha \pm 3\beta$$

where $\alpha = 82°$ and $\beta = 26\frac{1}{3}°$.

The central line (3) is that upon which the pole of the invariable plane lies, its position being chiefly dependent upon those of the poles of the orbits of Jupiter and Saturn.

2. The diagram on p. 387 also shows that there are several pairs of lines joining poles which are nearly parallel. These lines and their inclination to the central line (3) are as follows:—

(6) Uranus–Jupiter–Saturn,	0°.	Earth–Neptune,	− 4°.
(7) Mars–Venus, . .	+25°.	Earth–Jupiter, .	+27°.
(8) Neptune–Saturn, .	+49°.	Earth–Uranus, .	+51°.
(9) Uranus–Mercury .	+83°.	Neptune–Venus,	+84°.
(10) Neptune–Mercury, .	−85°.	Uranus–Mars, .	−85°.
(11) Mars–Saturn, . .	−30°.	Uranus–Neptune,	−29°.

The mean pole of the minor planets lies very close to the intersection of the lines Earth—Jupiter and Uranus—Neptune.

It will be noticed that the inclinations of the lines (9) and (10) to the central line are nearly the same, likewise those of (7) and (11).

* *M. N.*, vol. lxxvi. 5, pp. 386-9.

It may also be remarked that the lines Venus–Neptune, Earth–Jupiter, and Mars–Saturn are concurrent.

A consequence of the relations here indicated is that certain triangles formed by non-collinear poles are similar, and not far from being isosceles.

These triangles and their angles are as follows:—

Saturn–Jupiter–Neptune,	46°	50°	84°.
Uranus–Venus–Saturn,	48°	51°	81°.
Mars–Earth–Jupiter,	45°	51°	84°.

It has been pointed out that the angles of inclination of the collinear triads are related to one another as terms in an arithmetical progression whose common difference is $26\frac{1}{2}°$, and the lines (6), (7), (8) also have inclinations forming terms of this progression. Lines (9), (10), (11) do not fall into the progression, but their deviations from it are not very great.

3. It seems almost incredible that such definite relations between the positions of the poles should be purely accidental, yet there is nothing in the theory of the secular perturbations of the nodes and inclinations which would lead one to expect them to exist, or to continue to do so, if they did exist at a given time.

The theory shows that the lines joining the pole of the earth's orbit to those of Mars and Mercury possess a relative angular velocity of $14''{\cdot}651+0''{\cdot}00021t$ per annum, where t is the time in years from 1850. Also the lines joining the pole of the Earth to those of Venus and Uranus possess a relative angular velocity of $14''{\cdot}833-{\cdot}000554t$ per annum. Hence in these two cases the present approximate collinearity of the poles cannot persist indefinitely.

An examination of the Uranus, Jupiter, Saturn system leads to a similar conclusion.

One is inclined to think that the existence of these remarkable relations indicates the action of other forces, such as those due to a resisting medium, in addition to the purely gravitational, which are the only ones the theory takes into account. The gravitational forces are themselves very small, and produce perceptible alterations in the positions of the poles only after great intervals of time. The positions of the poles of the four exterior planets relative to the pole of the invariable plane are determined by multiples of three rotating vectors, whose periods of revolution are 50,000 years, 417,000 years, and 1,714,000 years respectively. Such intervals of time would be sufficient to enable forces, small even when compared with the recognised gravitational ones, to produce a perceptible effect.

King's College, London:
1916 *June* 6.

On a Probable Relation between the Changes in Solar Radiation and the Melting of the Polar Snow Caps of Mars. By E. M. Antoniadi.

On April 30 last, the writer detected an agreement between the erratic melting of the snow caps of Mars and the solar cycle.

Out of 21 cases of observed melting of the caps between 1862 and 1914 inclusive, there are 4 more or less unfavourable, and 17 favourable to the agreement in question.

The former are :—

1862. Very considerable solar activity : normal melting of S. cap, without local cloud ;

1873. Very considerable solar activity : normal melting of N. cap, but with frequent cloud ;

1877. Feeble solar activity : normal melting of S. cap, without cloud ;

1886. Normal solar activity : very rapid melting of N. cap, without cloud.

The favourable cases are :—

1871. Very great solar activity : rapid melting of N. cap, with frequent cloud ;

1879-1880. Minimum of solar activity : very slow melting of S. cap, in spite of absence of cloud ;

1881-1882. Considerable solar activity : very rapid melting of N. cap, with rather frequent cloud ;

1883-1884. Maximum of solar activity : rapid melting of N. cap, with rather few clouds ;

1888. Minimum of solar activity : very slow melting of N. cap, with rare cloud ;

1890. Insignificant solar activity : slow melting of N. cap, with very rare cloud ;

1892. Very considerable solar activity : rapid melting of S. cap, with very rare cloud ;

1894. Great solar activity : rapid melting, and precocious disappearance of S. cap, without cloud ;

1896-1897. Rather considerable solar activity : rather rapid melting of S. cap ; rather rapid melting of N. cap. White cloud appeared in both polar regions towards the close of the apparition.

1898-1899. Feeble solar activity : very slow melting of N. cap, with some cloud ;

1900-1901. Minimum of solar activity : exceedingly slow melting of N. cap, with rare cloud ;

1903. Normal solar activity : normal melting of N. cap, with rare cloud ;

1907. Very considerable solar activity : very rapid melting of S. cap, with rare cloud ;

1909. Rather normal solar activity : normal melting of S. cap, with occasional cloud ;

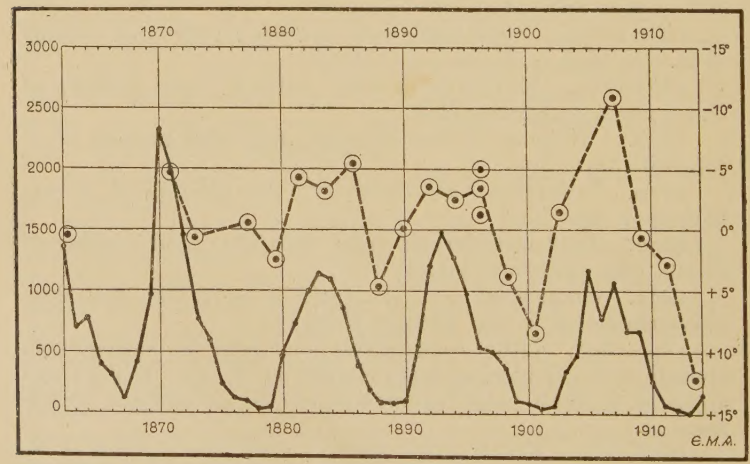
1911-1912. Insignificant solar activity : very slow melting of S. cap, with frequent cloud ;

1913-1914. Great minimum of solar activity : unprecedented slowness in the melting of the N. cap.

Such a close agreement between the two phenomena seems to point to something more than a mere coincidence. With a few exceptions, due to local causes on the planet, when sun-spots are numerous, the melting of the Martian caps is accelerated ; and when they are few, it is retarded. We are thus, probably, confronted with an objective confirmation, found in the solar system, of the conclusion that solar radiation is more powerful at the maximum of sun-spots, faculæ, prominences, and of the corona, than at the time of their minimum.

Paris, 74 *Rue Jouffroy* :
1916 *May* 18.

ADDENDUM.—Since the above was written, it appeared interesting to give a graphic representation of the general concordance between the phenomena in question. In the annexed diagram, the continuous, lower, curve shows the real spotted area of the sun, expressed, in the left-hand column, in millionths of the visible hemisphere. Here the data kindly supplied by Mr. Maunder have been used. The upper, discontinuous, curve con-



Curves showing the melting of the polar snow caps of Mars and the sun-spot cycle, from 1862 to 1914.

cerns the melting of the Martian polar snow caps with a corresponding scale to the right. This last curve has been obtained as follows : the mean daily areocentric arc subtended by either cap, during any apparition, was compared with the normal (1862 to 1912), and the difference marked *plus* in the case of a cap larger than the normal, *minus* in the case of a smaller one.

All positive differences were then added together, and the same was done for the negative. The smaller sum was then subtracted from the larger, and the final difference was divided by the number of days of observation. The quotient showed, for each apparition, by how many degrees the diameter of the cap was as a mean larger (+), or smaller (−), than the normal. Thus, in the diagram, the circle at +12°·2, for 1913-1914, for instance, implies that the N. cap, during that apparition, had a diameter which generally exceeded by 12°·2 that of the normal. It is noteworthy that the slowest recorded shrinkage of a cap of Mars coincided with the greatest well-observed solar minimum, that of three years ago.

The agreement between solar activity and the melting of the Martian snows is indeed closer than that given by the curves. In fact, the long persistence of the S. cap, near solar minimum, in 1879-1880, and in 1911-1912; that of the N. cap, soon after minimum, in 1890; and the precocious disappearance of the S. cap, shortly after maximum, in 1894, could not be shown on the diagram.

1916 *June* 2.

The Variable Nebula in Corona Australis (*N.G.C.* 6729). R.A. $18^h\ 52^m$. Dec. 37° 8′. By J. H. Reynolds. (Plate 13.)

These four photographs form part of a series obtained by Mr. Knox Shaw with the 30 in. reflector at Helwân, and are dealt with in the *Helwân Observatory Bulletin*, No. 16.

The nebula was discovered by Marth at Malta, and independently by Schmidt at Athens. The latter also discovered the variable stars R, S, and T Coronae Australis, and suspected the nebula itself to be variable. The nebula is attached to R Coronae Australis, and has since been observed visually by Innes at the Cape with the 7 in. refractor, and photographically at Johannesburg with the Franklin Adams star camera, and these observations confirmed the probability of its variation. The region has been under photographic observation at Helwân since the summer of 1911. Two photographs were obtained in 1911 (Aug. 18th and 21st) and one in 1913 (Aug. 6th). The difference in the appearance of the nebula at these two dates was so remarkable that there was little doubt that it was variable, and it was determined to make extended series of photographs of it in future summers. Consequently, eleven photographs were secured in 1914 and twenty-six in 1915. The field in which the nebula appears is very remarkable and unusual. There is a large bright globular cluster (N.G.C. 6723), an irregular nebula (N.G.C. 6726, 6727) containing two stars of 6·7 and 8 magnitudes,* the variable stars R, S, and

* C. P. D. scale.

T, and a comparative absence of stars in and around the nebulous region.

There can be no doubt from the photographs that the nebula is variable, and that its variability is closely connected with the star R Coronae Australis. Not only does its brightness vary but it varies in form : it has, in fact, every appearance as if the nebulous matter was discharged from the star when at its maximum brightness, as well as illuminated by it.

It is worth noting that the nebulosity is concentrated on the side of the star away from the irregular nebula (N.G.C. 6726, 7) and its involved stars. It is also a significant fact that the irregular variable T Tauri, which is close to the position of a suspected variable nebula, has been found at Mount Wilson to be surrounded by a nebulous atmosphere giving a bright line spectrum.

1916 *April* 13.

Note on the Variable Nebula in Corona Australis.

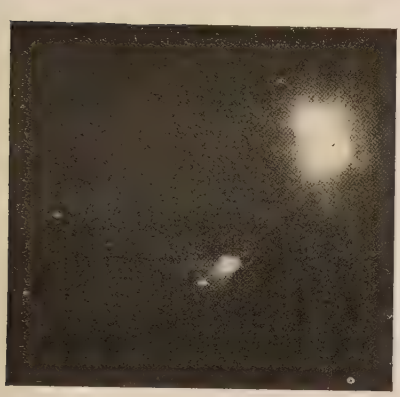
By H. Knox Shaw, M.A.

It is now possible for me to give some additional information about the nebula and the stars near it, which was not available to Mr. Reynolds when he wrote his note. The four photographs which accompany this note have been chosen from the forty taken in the summers of 1911, 1913, 1914, and 1915. A fuller selection—twenty lantern slides—has been presented to the Society. The forms of the nebula shown on these have been provisionally divided into seven types, ranging from the first type—the photograph of 1911 Aug. 21 is an example—where the nebula is very bright, and attached to the star R Coronae, to the seventh type—shown on 1915 May 23—where the nebula is very faint and entirely detached from the star. The intermediate types differ as much in the shape of the nebula as in its brightness.

It must be remembered that the series has naturally been taken on nights of very different transparency—the sky differs much in transparency on clear nights at the low altitude of 23° to which the nebula rises on the meridian at Helwân—and the photographs have been taken under different instrumental conditions and with two different brands of plates. The exposures have been regulated as far as possible to allow for these latter (not the atmospheric) changes, and the nebula north preceding the variable nebula makes a good comparison object. This nebula (N.G.C. 6726, 7) contains two stars, the north following of which, C. P. D. – 37° 8450, has been announced by Mr. Innes as variable.* He has also stated that the part of the nebula which surrounds this star is also variable. Though the Helwân

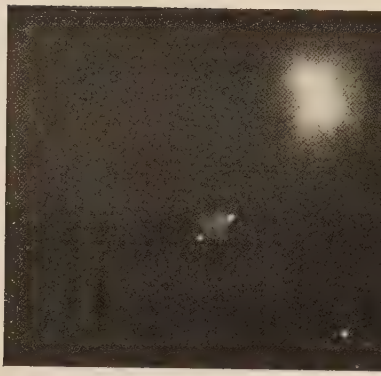
* *Union Observatory Circular, No.* 33.

1.



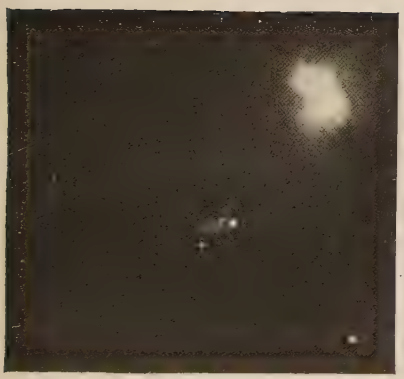
1911 August 21.

2.



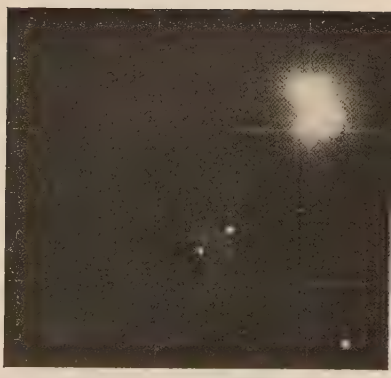
1915 September 8.

3.



1913 August 6.

4.



1915 May 23.

THE VARIABLE NEBULA N.G.C. 6729.

plates confirm the variability of the star, they afford no evidence of any variability in that part of the nebula which surrounds it.

The following conclusions can at present be drawn, and, I think, are reliable :—

(1) The star R is an irregular variable. It has ranged during the last four years between magnitudes 12·9 and 14·3 on the revised Harvard Photographic Scale. No period which has been derived for it has not subsequently broken down.

(2) The star T is not variable, at any rate over a range of more than 0·3 magnitude, but is constant at 13·9 on the same scale.

(3) There is no *simple* relation between the form of the nebula and the magnitude of R. The nebula is brightest, *i.e.* of the first type, when R is brightest, but is not always of the same form for a given magnitude of R. It seems quite impossible at present to predict what the nebula is like from a knowledge of the magnitude of R. About half the plates show the nebula of the first type.

(4) Plates taken on consecutive nights usually show the same type, but plates taken at intervals of a week, or even less, often show markedly different types.

It seems quite possible that the variation of R Coronae and that of the nebula may well be complicated by the presence of the absorbing medium which apparently lies between them and us. Should this medium be in motion and thicker parts come at various times in front of the star and nebula this would naturally cause a variation in their appearance to us. I would not suggest this as the main cause of the variability, but as a subsidiary one complicating the problem. The variation of a faint star south following the nebula is just such as one would expect if it was caused by motion in front of it of an absorbing medium of variable thickness. I hope soon to publish a fuller discussion of the observations as a bulletin of the Helwân Observatory.

1916 *July* 11.

The Nebula H II. 78 *Leonis.* By Mrs. Isaac Roberts. (Plates 14, 15.)

The nebula H II. 78 Leonis (h 748, G.C. 2193, N.G.C. 3367) was photographed at Starfield, Crowborough, in 1902, and is found in the Isaac Roberts' Collection of Celestial Photographs, on the plate :

I. R.* 3038 April 6, 1902 : Exp. $1^h\ 30^m$ from $9^h\ 7^m$ to $10^h\ 37^m$ S.T. Crowborough, and on the 5-inch Camera

plate 1373, obtained simultaneously with the 20-inch Reflector plate 3038.

The nebula is described as follows in the Isaac Roberts' Register of Celestial Photographs:

3038: sky clear, frosty; stars round and pretty numerous. H II. 78 Leonis is a left-hand spiral nebula with bright stellar nucleus and condensations in spirals.

The nebula was observed at Birr Castle in 1851–52–63, at first as a triple nebula:

1851 March 23: The triple nebula is probably spiral, dark spaces in it and a star suspected in p edge.

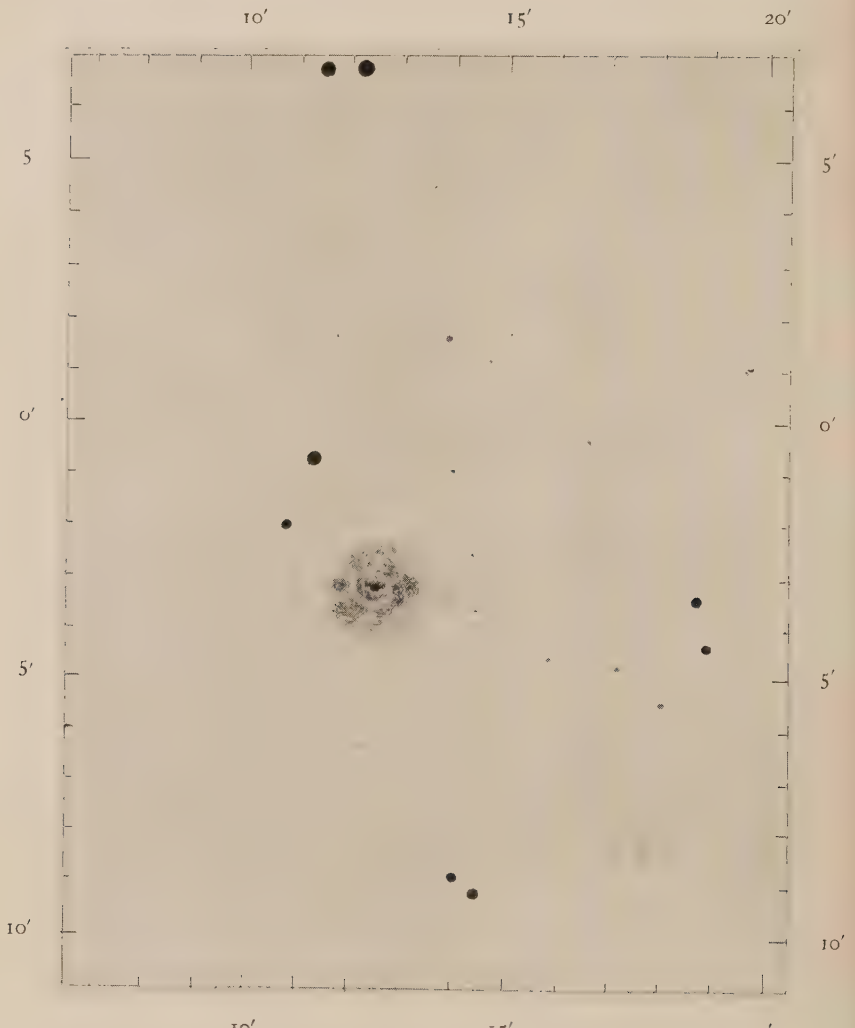
1852 March 19: only h 748 seen of the three, it is brighter in the middle, a double star 8′ north.

1863 March 20: I found one very bright, little elongated (nebula), [G.C. 2196=h 751 and G.C. 2198=h 753 have not been seen by anybody except h], the "triple nebula" must be h 748.

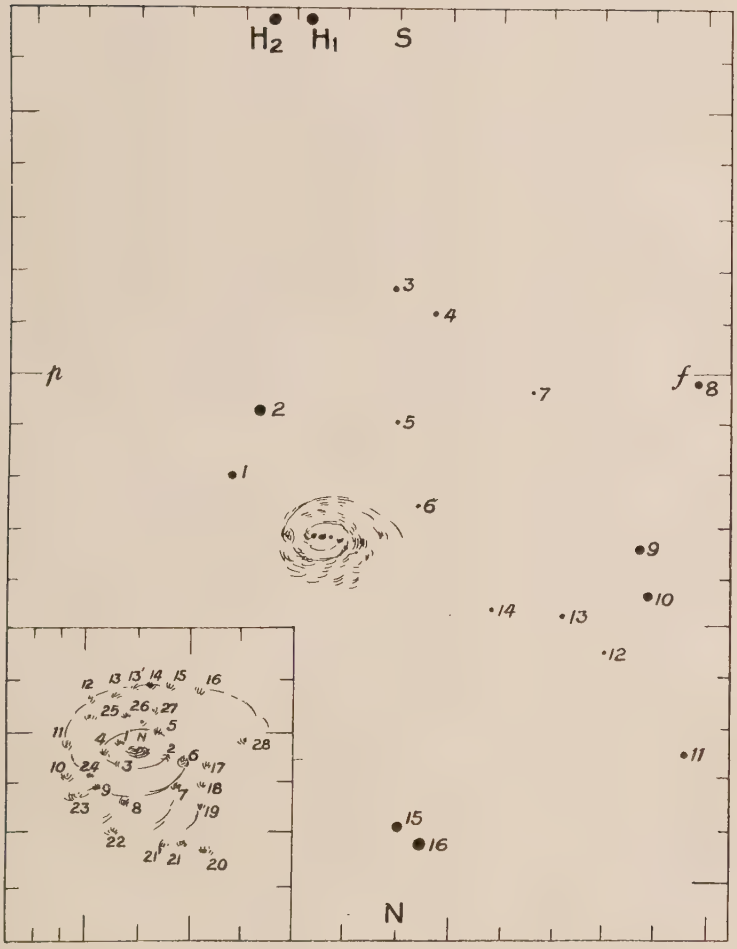
In the N.G.C. the nebula is described as: pB, cL, iR, vglbM, r, 1st of 3.

Further Description. — The left-hand spiral nebula H II. 78 Leonis measures about 2′ from n to s and 2′·5 from p to f, the dense stellar central nucleus being encircled twice by the spiral arm. The innermost arc is especially well defined in its northern course, where it passes over the nebulous knots 2, 3, and 4; in its southern course it is much fainter and less regular; the dense nebulous masses: 2, 6, 7 on the f side of the nucleus are very conspicuous; together with the nucleus and the dense nebulous knot marked 11, they may have suggested the aspect of a triple nebula. The fainter and larger northern arc passes over the nebulous knots: 7, 8, 9, 24: at knot 11 it reaches the western border of the nebula and then runs south-eastward, passing over very faint knots among which 12, 13, 13′, 14, 15, 16 were measured. Beyond knot 16, the nebula decreases rapidly in intensity; there seems to be an outflow of nebulosity in the f and nf regions. Lateral streamers of nebulosity are distinguishable in the northernmost parts of the nebula, passing over the nebulous knots: 17, 18, and 19; 7 and 21; 8 and 22; 9 and 23; 24 and 10; there also appear to exist lateral streamers in the interspiral space south of the nucleus, the most prominent being the one defined by the nebulous knots 25 and 12.

Among the stars surrounding the nebula H II. 78, those numbered 1, 2 . . . . . 19 were measured, 17, 18 and 19 are beyond the limits of my diagram, and 8 and 11 near the f border; stars 6, 7, 13, 14 are exceedingly faint; 15 and 16 appear to be the double star north of the nebula to which the Birr Castle observer referred in 1852; south of the nebula is a brighter



The Nebula H II. 78 Leonis. I.R.* 3038.



KEY MAP.

double star formed by H_1 and H_2 measured and inscribed in the annexed tables; H_1(B.D.+14°2295) being one of the standard stars of the plate.

The nebula h 751 (G.C. 2196, N.G.C. 3371) described in the N.G.C. as eF, R, 2nd of 3, and observed by Peters, is not visible on the I. R.* plate 3038; its position as given in the N.G.C. would correspond on the diagram to about X=+29′3, Y=+5′5; it would be nearly on the same parallel as the star 12.

The 3rd nebula, h 753 (G.C. 2198, N.G.C. 3373), described in the N.G.C. as F.R. 3rd of 3, would correspond in position to about X=+22′2, Y=−1′0, of star 8 and close nf star 1 (B.D.+14°2297); in that region there are, on the I. R.* plate 3038, knots or extremely faint stars requiring a longer exposure, but there is no nebulosity visible.

Near the centre of the plate I. R.* 3038 is the very faint nebulous patch p_1; further west is p_2 diffused and elongated; other similar objects are visible on the plate, they appear to be extremely faint stars requiring a longer exposure; stars 18, 19 and G, well defined, are near the centre of the plate, I. R.* 3038, upon which are found the following nebulae, at greater distances from the centre than the nebula H II. 78 Leonis.

H II. 99 Leonis (h 754, G.C. 2201, N.G.C. 3377) elongated in position angle 40°, presents a dense stellar nucleus, intensity 2, 21″ in diameter, the dense central region covers about 1′ and 0′5; the fainter nebulosity extends over 2′2 and 1′ in major and minor axes. The nebula is in the nf region of H II. 78; the tables annexed contain the positions of the nucleus of H II. 99 and of some faint knots and stars in its adjacent regions: kn 20, an extremely faint knot or a very small star, on the p side of H II. 99, involved in nebulosity; kn 21, an extremely faint knot or star, preceding star 22 and the double star 23, 24 (23 differing in aspect from the brighter star 24); star 25, a faint star, intensity 15 north preceding H II. 99, is on the f margin of the faint nebulous patch α. H II. 99 is described in the N.G.C. as: vB, cL, lE, svmbMBN.

m 202 (=G.C. 5533=N.G.C. 3357) presents a dense nucleus, intensity 6, diameter 9″, surrounded by faint nebulosity, intensity 16 extending over 20″ in diameter; the nucleus and the stars in the adjacent regions: 26, 27, 28 were measured. m 202 is described in the N.G.C. as F.S. mbN.

H II. 77 Leonis (h 737, G.C. 2175, N.G.C. 3338) is near the p border of the I. R.* plate 3038 and requires a more favourable exposure. It is a right-hand nebula measuring from p to f about 4′5 and from n to s about 3′. Its stellar nucleus, the bright star B (B.D.+14° 2284) near its p summit and the faint nebulous knot m_1 in its np region were measured. H II. 77 is described in the N.G.C. as: F, eL, E, vgbM, *7 p 10^s.

On the s border of the plate are the nebulae H I. 17 and H I. 18, too far from its centre for accurate measurements.

Objects of nebulous aspect were found on the plate:

α np H II. 99, intensity 18, measuring over 1′, round, with a star at its margin, seems to be spurious.

β near the stars 29, 30, 31, is a dense patch of nebulosity (?) oval in shape, about 1′, and 0′·5 from p to f and from n to s, with a nucleus placed eccentrically.

γ small knot involved in nebulosity (?) intensity 16, north of star 32.

Confirmation as to the reality of these three objects is desired.

Measures.—The Isaac Roberts' plate 3038 was measured by me in April 1913 with the Isaac Roberts' "Stellar Pantograver" (*M. N.*, xlix. pp. 5-13).

As on former occasions, the measured rectangular co-ordinates were communicated to Mr. Pourteau of the Paris Observatory who computed the constants of the plate.

The spherical co-ordinates of all the objects measured were computed by me with the assistance of Madeleine Bougreau and Germaine Bontemps. The computations were made in duplicate throughout.

The following tables contain the measures of all the objects studied on the I. R.* plate 3038, and the results derived therefrom, together with a brief description of the nebulous knots involved in the nebula H II. 78.

I. R.*3038.

Places for 1900·0 *of the Standard Stars from which the Constants were derived.*

	No.*	R.A.	Decl.	Measured Co-ordinates.		Concluded positions.		Diameters of star images.		Mag.	B.D.	Authority.	
		h m s	° ′ ″	′	′	s	″	″	″		°		
A	88_1B	10 36 32·18	+14 27 47·4	−55·862	+17·008	32·17	46·6	32	29	9·0 K	+14 2283	Bordeaux	Astrographic Catalogue.
B	89_1	10 36 38·26	+14 16 45·1	−54·849	+ 5·947	38·29	45·4	38	33	8·5 L	+14 2284	,,	,,
C	104_1	10 39 1·16	+14 4 36·2	−20·737	− 7·572	1·24	36·6	25	21	9·5 −	+14 2288	,,	,,
D	105_1	10 39 20·53	+14 43 39·2	−14·531	+31·219	20·50	39·4	25	23	9·5 B	+14 2289	,,	,,
E	$107_1 61_2$	10 40 4·34	+14 42 7·4	− 4·012	+29·291	4·30	8·0	22	21	9·5 B	+14 2291	,,	,,
F	4102	10 40 19·71	+13 40 17·8	− 2·689	−32·562	19·61	18·1	27	29	9·2 K	+13 2298	Leipzig I	
G	$108_1 63_2$	10 40 17·47	+14 18 33·9	− 1·743	+ 5·640	17·45	33·5	27	24	9·1 −	+14 2293	Bordeaux	Astrographic Catalogue.
H_1	68_2	10 41 16·91	+14 6 43·8	+12·217	− 6·707	16·96	43·4	23	23	9·1 K	+14 2295	,,	,,
I	73_2	10 41 50·97	+14 11 28·3	+20·635	− 2·272	51·00	28·0	26	25	9·0 K	+14 2297	,,	,,
J	4144	10 42 7·06	+13 54 21·9	+23·899	−19·477	7·06	22·2	31	28	8·5 K	+14 2298	Leipzig I	
K	77_2	10 42 45·44	+14 44 22·1	+34·993	+30·098	45·43	21·7	38	34	8·5 K	+14 2299	Bordeaux	Astrographic Catalogue.

* Suffix 1 referring to the Bordeaux plate No. 919; suffix 2 to the Bordeaux plate 633.

*The Constants and Concluded Centre of the plate I. R.*3038.*

$tx = -0.00031$ $ty = +0.00049$

$ix = -0.03837$ $iy = -0.03757$

$\alpha_0 = 10^h 40^m 25.53^s$ $\delta = +14°12'58.8''$

The Nebula H II. 78 Leonis.

	Objects.	Measured Co-ordinates.		Concluded Places for 1900·0. R.A.	Decl.	Diameters.		Intensit
		′	′	h m s	° ′ ″	″	″	
	N	+12·554	+3·190	10 41 16·83	+14 16 38·3	10	8	7
Kn	11	+11·784	+3·168	41 13·66	16 35·3	9	9	14
,,	10	+11·838	+3·480	41 13·83	16 54·1	6	5	15
,,	23	+11·889	+3·605	41 14·02	17 1·7	7	5	16
,,	12	+12·104	+2·681	41 15·04	16 6·7	6	6	16
,,	25	+12·138	+2·827	41 15·17	16 15·5	7	7	16·17
,,	24	+12·139	+3·481	41 15·07	16 54·7	8	6	16
,,	9	+12·153	+3·579	41 15·11	17 0·7	8	7	16
,,	4	+12·203	+3·212	41 15·37	16 38·8	7	7	13
,,	22	+12·239	+3·926	41 15·41	17 21·7	7	8	16
,,	13	+12·330	+2·637	41 15·99	16 4·5	7	7	17
,,	3	+12·338	+3·330	41 15·91	16 46·2	6	7	13
,,	1	+12·359	+3·143	41 16·02	16 35·0	5	5	15
,,	26	+12·410	+2·848	41 16·28	16 17·4	6	6	17
,,	13′	+12·450	+2·609	41 16·48	16 3·2	7	6	16
,,	8	+12·466	+3·703	41 16·38	17 8·8	8	6	17
,,	26′	+12·503	+2·876	41 16·66	16 19·3	6	6	18
,,	14	+12·630	+2·559	41 17·24	16 0·5	9	7	15
,,	27	+12·695	+2·800	41 17·47	16 15·1	9	6	15
,,	21′	+12·729	+4·104	41 17·41	17 33·5	5	6	17
,,	5	+12·782	+3·063	41 17·79	16 31·1	7	7	15
,,	2	+12·849	+3·291	41 18·03	16 45·0	7	7	13
,,	21	+12·855	+4·165	41 17·92	17 37·5	5	6	18
,,	15	+12·882	+2·580	41 18·27	16 2·4	7	7	15
,,	7	+12·888	+3·546	41 18·15	17 0·4	8	10	15
,,	6	+12·960	+3·289	41 18·49	16 45·1	9	9	12
,,	20	+13·139	+4·212	41 19·08	17 40·9	8	5	18
,,	18	+13·146	+3·561	41 19·21	17 1·9	7	7	16
,,	16	+13·148	+2·638	41 19·36	16 6·4	6	7	18
,,	19	+13·153	+3·719	41 19·21	17 11·4	9	7	16
,,	17	+13·163	+3·309	41 19·32	16 46·8	7	9	12·16
Kn	28	+13·559	+3·125	10 41 20·98	+14 16 36·5	10	8	17

Stars in the region of H II. 78 Leonis.

No.	Measured Co-ordinates.		Concluded Positions for 1900·0. R.A.			Decl.			Diameters.		Intensity.
	′	′	h	m	s	°	′	″	″	″	
*19	- 5·704	+1·991	10	40	1·69	14	14	45·3	5	6	14
p_2	−5·384	+1·611		40	3·06		14	23·3	20	8	16·18
*18	−2·802	+2·172		40	13·63		15	2·9	11	7	6·12
p_1	- 0·330	+0·173		40	24·14		13	8·4	10	5	16
*17	+5·559	+14·478		40	46·19		27	40·4	13	11	4
*1	+10·764	+1·958		41	9·63		15	20·4	16	14	4
*2	+11·431	+0·658		41	12·59		14	3·7	17	15	3
*3	+13·890	−1·639		41	23·08		11	51·3	8	7	10
*5	+13·998	+1·032		41	23·11		14	31·8	6	5	15
*15	+14·023	+8·872		41	22·01		22	22·5	13	10	6
*16	+14·367	+9·217		41	23·38		22	44·1	17	15	3
*6	+14·377	+2·634		41	24·43		16	8·9	5	6	16
*4	+14·727	−1·183		41	26·46		12	20·5	7	6	15
*14	+15·889	+4·620		41	30·37		18	11·4	7	5	17
*7	+16·595	+0·411		41	33·92		14	0·3	14	6	16
*13	+17·208	+4·757		41	35·79		18	22·4	8	7	16·17
*12	+18·075	+5·502		41	39·25		19	9·2	7	7	10
*9	+18·760	+3·502		41	42·39		17	10·6	16	14	3
*10	+18·983	+4·430		41	43·16		18	6·7	11	8	7
*11	+19·394	+7·303		41	44·42		21	0·1	10	8	6
*8	+19·721	+0·158		41	46·86		13	51·9	8	6	12
*H_2	+11·500	−6·753	10	41	14·01	14	6	39·0	21	21	3

Other Nebulae and Objects of Nebulous Aspect on the I. R. plate 3038 and stars in the adjacent regions.*

	Objects.	Measured Co-ordinates.		Concluded Positions for 1900·0. R.A.			Decl.			Diameters.				Intensit
		′	′	h	m	s	°	′	″	′	″	′	″	
N.G.C. 3338	H II. 77	−52·312	+5·269	10	36	48·87	14	16	11·0	11 4	8 30	3	0	10·16
	Kn m_1	−56·130	+6·050		36	32·99	14	16	48·4	9		11		17
	*30	−43·786	−12·669		37	27·11	13	58	35·6	20		16		6
	*29	−43·637	−10·771		37	27·39	14	0	29·9	28		22		3
	β	−43·007	−12·281		37	30·25	13	59	0·7	10 1	6	7 0	40	9·14
	*31	−38·746	−9·343		37	47·31	14	2	7·4	27		24		16·17
	*28	−25·920	+16·105		38	35·94	14	28	5·5	7		6		14
	*27	−21·294	+14·836		38	55·25	14	27	0·3	18		14		5
N.G.C. 3357	m 202	−19·286	+24·298		39	1·98	14	36	33·0	10 20		9 20		6·16
	*26	−17·886	+24·222		39	7·78	14	36	31·7	9		6		6·17
	*32	+4·904	−26·732		40	49·94	13	46	25·1	17		18		4
	γ	+5·720	−24·119		40	52·89	13	49	3·7	36		36		16
	*24	+23·782	+14·861		42	1·39	14	28	43·2	8		4		9·16
	*23	+23·929	+14·635		42	2·04	14	28	30·0	12		7		5
	α	+24·721	+21·872		42	4·21	14	35	46·2	15 1	30	12 1	30	18
	*25	+25·249	+21·871		42	6·39	14	35	47·3	10		9		15
	Kn 21	+25·560	+11·109		42	9·30	14	25	1·9	17		16		15·16
	*22	+26·635	+10·655		42	13·81	14	24	36·9	13		10		5
	Kn 20	+27·771	+16·682		42	17·59	14	30	41·2	7		7		14
N.G.C. 3377	H II. 99	+29·337	+16·731	10	42	24·05	14	30	47·4	29 3	0	21 1	10	4·16

Definition and Description of the knots measured in H II. 78.

N, dense central nucleus.
kn 1, dense knot on p side of nucleus.
kn 2, 3, 4, knots in the northern arc of the inner spiral.
kn 5, knot in the southern arc.
kn 6, large diffused nebulous knot on f side of the inner spiral.
kn 8, kn 9, knots in the northern arc of the larger inner spiral.
kn 10, kn 11, knots near the p border of the nebula.
kn 12, kn 13, kn 13′, kn 14, kn 15, kn 16, faint knots involved in nebulosity forming the southern border of the nebula.
kn 17, multiple knots involved in nebulosity.
kn 18, kn 19, faint knots in f streamer.

kn 20, kn 21, kn 21′, kn 22, kn 23, very faint knots near the northern border of the nebula.
kn 24, faint knot south of kn 9 forming together a double knot.
kn 25, forming a double knot with kn 12.
kn 26, double, measured as 26 and 26′.
kn 27, faint, in the interspiral space.
kn 28, very faint knot involved in diffused nebulosity forming the f extremity of the spiral arm. Other similar knots are found in this region of the nebula.

Maison de Rosa Bonheur,
By-Thomery :
1916 *April.*

Micrometrical Measures of Double Stars.

By Rev. T. E. R. Phillips, M.A.

The following measures were made at Ashstead during the year 1915 with the Coleman Equatorial lent by the Society. Various circumstances combined to diminish the amount of double star work done, and in December the instrument was dismounted for removal to Headley Rectory, near Epsom.

Special attention was paid to the star ξ Bootis (Σ 1888), and observations were made in groups as the position angle is changing very rapidly, and the *comes* deviating from the provisional orbit suggested by Mr. Lewis on p. 399 of vol. lvi. of the *Memoirs*.

The places and magnitudes of the Struve pairs are taken from the same volume, the former being corrected for precession to 1910.

In the last column A=H. F. Acocks, P=T. E. R. Phillips.

Star.	1910. R.A. h m	Dec. ° ′	Mag.	Position Angle °	Distance. ″	No. of Nights.	Date.	Observer.
Σ 60 (η Cassiop.)	0 43·6	+57 20	4·0, 7·6	251·6	6·80	4	1915·778	P
73 (36 Androm.)	0 50·8	23 8	6·2, 6·8	43·0	0·90	2	·918	P
205 (γ^2 Androm.)	1 58·4	41 54	5·5, 6·5	113·2	0·56	3	·783	P
333 (ε Arietis)	2 54·1	20 59	5·7, 6·0	203·2	1·36	2	·942	P
O Σ 95	5 0·2	19 41	6·5, 7	322·2	0·83	3	·893	P
98	5 3·0	8 23	6, 7	146·8	0·96	3	·912	P
170	7 12·7	9 28	7·5, 7·5	104·2	1·66	3	·086	P
Σ 1110 (Castor)	7 28·9	32 6	2·7, 3·7	217·3	5·11	3	·883	P
1356 (ω Leonis)	9 23·7	9 26	6·2, 6·7	125·6	0·96	3	·049	P
1424 (γ Leonis)	10 15·0	20 18	2·0, 3·5	117·0	3·64	3	·358	P
1439	10 25·1	21 16	8·0, 8·5	108·6	1·57	3	·081	P
1457	10 34·0	6 12	7·6, 8·5	320·6	1·22	3	·115	P

Star.	1910. R.A. h m	Dec. ° ′	Mag.	Position Angle. °	Distance. ″	No. of Nights.	Date.	Observer.
1500	10 55·6	−3 0	7·6, 8·2	311·9	1·37	3	1915·163	P
1504	10 59·4	+4 7	7·5, 7·6	289·2	1·23	3	·157	P
1527	11 14·3	14 45	6·9, 8·1	19·0	3·01	3	·219	P
1670 (γ Virginis)	12 37·0	−0 57	3·3, 3·3	324·8	5·79	3	·326	P
1781	13 41·6	+5 34	7·8, 8·2	285·2	1·07	3	·445	A
1865 (ζ Bootis)	14 36·9	14 6	3·5, 3·9	139·8	0·72	4	·247	P
1888 (ξ Bootis)	14 47·2	19 28	4·7, 6·6	103·1	2·17	6	·231	P
,,				101·9	2·12	2	·506	A
,,				99·9	2·15	5	·586	P
1910	15 3·2	9 35	7·0, 7·0	209·5	4·43	3	·458	A
1937 (η Coronæ)	15 19·5	30 37	5·5, 6·0	56·9	0·84	4	·569	P
2032 (σ Coronæ)	16 11·3	34 4	5·0, 6·1	217·1	4·84	3	·363	P
2055 (λ Ophiuchi)	16 26·3	2 11	4·0, 6·1	70·9	0·98	4	·375	P
2084 (ζ Herculis)	16 37·9	31 45	3·0, 6·5	112·2	1·32	6	·439	P
2140 (α Herculis)	17 10·5	14 29	3·0, 6·1	112·4	4·61	3	·404	P
2262 (τ Ophiuchi)	17 58·2	−8 11	5·0, 5·7	260·4	2·11	3	·477	A
2272 (70 Ophiuchi)	18 1·0	+2 32	4·5, 6·0	140·0	4·53	3	·493	A
				140·6	4·49	4	·437	P
2374	18 39·9	27 38	8·8, 9·2	36·6	14·33	3	·531	A
2375	18 41·1	5 25	6·2, 6·6	114·3	2·53	3	·610	A
2382 (ϵ^1 Lyræ)	18 41·3	39 35	4·6, 6·3	8·9	2·85	3	·415	P
2383 (ϵ^2 Lyræ)	18 41·4	39 31	4·9, 5·2	122·0	2·28	3	·415	P
2402	18 45·5	10 35	8·0, 8·4	204·1	1·30	2	·637	P
2583 (π Aquilæ)	19 44·4	11 35	6·1, 6·7	113·9	1·56	2	·732	P
2596	19 49·9	15 4	7·0, 8·5	327·7	1·90	4	·507	P
2628	20 3·4	9 8	6·1, 8·2	342·6	3·98	3	·551	A
2631	20 3·2	20 51	8·0, 9·4	337·3	4·44	3	·575	A
2695 (94 Vulp.)	20 28·1	25 30	6·8, 8·0	75·8	1·05	3	·563	P
2723	20 40·6	11 59	7·3, 8·0	100·1	1·18	3	·599	A
O Σ 413 (λ Cygni)	20 43·9	36 10	5, 6	51·0	0·69	3	·586	P
Σ 2822 (μ Cygni)	21 40·1	28 19	4·0, 5·0	131·8	1·81	3	·605	P
2909 (ζ Aquarii)	22 24·2	−0 29	4·0, 4·1	308·8	2·93	2	·639	P

Headley Rectory,
Epsom:
1916 *June.*

Eleventh Note on the Number of Faint Stars with Large Proper Motions. By R. J. Pocock, B.A., B.Sc.

The proper motions contained in the present note are the result of a comparison of 5 recent Oxford plates, measured at Hyderabad, with the printed measures for the same regions. The particulars are as follows :—

TABLE I.

List of Regions compared.

Region.	Dec.	R.A.	Interval in Years.	No. of Stars.	No. of P.Ms.
	°	h m			
I	+25	19 48	11·0	524	2
II	+29	19 25	16·1	649	12
III	+29	23 10	16·2	399	6
IV	+29	23 28	16·2	335	3
V	+29	23 46	16·2	392	7

The proper motions are given in the following Table II., the photo-magnitudes are in every case determined from the diameters given in the *Oxford Catalogue* by means of the formulae printed at the head of the measures.

TABLE II.

Ref. No.	Region.	Oxford No.	ϕ mag.	Δx (unit 0″·3).	Δy	Centennial P.M. in Arc.
		°				″
1	V	29·69437*	7·7	+32	+5	59·4
2	V	29·69792*	9·4	+12	0	22·2
3	V	29·69635*	8·4	−2	−10	18·9
4	II	29·49755	9·9	−6	−8	18·6
5	I	25·63606	10·6	0	−6	16·4
6	I	25·63845*	9·2	0	−5	13·7
7	IV	29·68943	10·8	−2	−7	13·5
8	IV	29·68641	10·4	−4	−6	13·3
9	III	29·67753	10·5	+6	+4	13·3
10	II	29·49767	11·0	−4	−5	13·2
11	V	29·69801	11·5	+1	−7	13·1
12	III	29·68019	11·5	+7	+1	13·1
13	III	29·68075	11·3	+7	0	13·0
14	II	29·50106	11·7	+6	+2	11·8
15	II	29·49988*	10·7	+1	−6	11·3
16	V	29·69573	9·4	+5	−3	10·8

TABLE II.—*continued.*

Ref. No.	Region.	Oxford No.	ϕ mag.	Δx (unit 0″·3).	Δy	Centennial P.M. in Arc.
		°				″
17	II	29·49758	11·0	−5	+3	10·8
18	IV	29·68615*	9·4	−4	+4	10·5
19	II	29·49776*	8·7	+2	+5	10·0
20	V	29·69625	11·0	+2	+5	10·0
21	III	29·67895	11·0	+5	+2	10·0
22	III	29·67917*	7·8	+5	+2	10·0
23	II	29·49795	10·8	−4	−3	9·3
24	II	29·49753	11·7	−3	+4	9·3
25	II	29·50344	11·7	−4	+3	9·3
26	II	29·49786	9·9	0	+5	9·3
27	III	29·68095*	7·6	−5	0	9·3
28	II	29·49798	10·5	0	−5	9·3
29	V	29·69717	11·3	0	−5	9·3
30	II	29·49830	11·3	+4	+3	9·3

No. 1 is in List D., *Oxf. Cat.*, vol. viii.

No. 2 is in List B., *Oxf. Cat.*, vol. viii.

No. 6 is in Berlin, all the other stars with an asterisk are in Cambridge A.G.C.

The proportion of faint stars is 21 to 9 brighter stars in the meridian catalogue.

The limiting proper motion in any given case depends on the interval between the plates; if this interval is n years the limiting proper motion may be taken to be $(100 \times \sqrt{29} \times 0''{\cdot}3)/n = \tau$ (say). But the percentage of proper motions greater than τ varies as $\tau^{-2} = k/\tau^2 = N$ (say). (See *M. N.*, vol. lxxvi. p. 423). Now if N_1, τ_1 correspond to an interval n_1 years, we have

$$\frac{N}{N_1} = \frac{\tau_1^2}{\tau^2} = \frac{n^2}{n_1^2},$$

hence if N_1 is known we can compute N the percentage of proper motions which we may expect to determine from plates having an interval of n years.

From the previous notes of this series we can collect the number of proper motions determined after given intervals, the numbers per thousand stars are given below, the two numbers in brackets depend on only 3 and 4 plates respectively.

No. of p.ms. per thousand stars from plates with given intervals.

Int. in yrs.	<10	10·5	11·5	12·5	14·5	15·5	16·5
No. per 1000	14·4	18·8	17·2	24·3	26·2	33·1	44·9
Do. $\times\tau^2$.	471	500	382	457	364	407	485

According to the above formula the numbers in the last row should all be the same; the mean is 440, and using this number the percentage of p.ms. with an interval of 10·5 years becomes 1·65 instead of 1·88; using this value for N_1 and $n_1 = 10{\cdot}5$ we can extrapolate from these numbers by the above formula, and determine the number of years required to give a given percentage of proper motions.

Calculated Percentages of Proper Motions.

Percentage .	2	4	6	8	10	50	100
Int. in yrs. .	11·5	16·4	20·1	23·1	25·8	57·8	81·7

It will be seen that the observed numbers agree well with the theoretical numbers, and we may with some confidence accept the numbers beyond 17 years as being not far from the truth.

Nizamiah Observatory,
Hyderabad:
1916 *March* 25.

Baxendell's Observations of Variable Stars. Seventh Instalment: No. 17, *R Sagittae; No.* 18, *R Serpentis; No.* 19, *T Serpentis.* Edited by H. H. Turner and Mary A. Blagg.

No. 17. *R Sagittae* (Chandler 7257).

$20^h\ 7^m\ 27^s \quad +16^\circ\ 17'{\cdot}4\ (1855{\cdot}0).$
$20\ 9\ 30 \quad +16\ 25{\cdot}4\ (1900{\cdot}0).$

The Comparison Stars.

Baxendell made two charts for this variable, one dated July 30, 1866, the other (apparently earlier) undated. In the latter 2 different stars are marked *b*. In his observations he called 3 different stars *a*, and 2 different ones *b*. These circumstances made the identification of his comparison stars unusually difficult; but from internal evidence there seems little doubt that the various *a*'s and *b*'s have now been correctly interpreted. The first and third *a*'s were never compared with the variable; the first *b* was used from 1860 May, until 1879, and the second *b* (=second *a* of 1859 Oct. 26 and 27) was used from 1859 Oct. 29 to 1860 Jan. 17, on three nights in 1878, and from 1880 onwards. The following table gives the identifications of these stars.

TABLE I.

Baxendell's Designations.

A. S. V. No.	H. A. Mag.	1st Chart.	2nd Chart July 30, 1866.	Used in 1859 Oct. 6-21.	Used from 1859 Oct. 24 to 1879.	Used from 1880.	Adopted Mag.
12	8·16	*b*	*a*	–	[3rd] *a*	–	–
15	8·78	(*b*)	–	–	[1st] *b*	–	88
		a & 22	*b*	22	[2nd] *a* & [2nd] *b*	[2nd] *b*	90
19	9·11	*c*	*c*	–	*c*	*c*	91
24	9·07	*e* & 27	*e*	27	*e*	*e*	93
35	–	*g*	*g*	–	*g*	*g*	102
40	10·36	*f* & 21	*f*	21	*f*	*f*	102

TABLE II.

Baxendell's Differences between his Comparison Stars.

(The subscript figures give the number of observations.)

Year.	90-88.	91-90.	93-90.	91-88.	93-91.	93-88.	102 (*f*)-93.	102 (*g*)-93.
1859-64	–	$1\cdot6_{9}$	$4\cdot6_{22}$	$2\cdot8_{55}$	$3\cdot2_{84}$	$6\cdot3_{156}$	$8\cdot1_{36}$	$8\cdot5_{20}$
1865-9	–	–	–	$3\cdot7_{4}$	$2\cdot1_{4}$	$5\cdot9_{75}$	$9\cdot4_{26}$	$8\cdot8_{10}$
1878-9	$2\cdot3_{3}$	$0\cdot7_{3}$	$6\cdot0_{1}$	$3\cdot0_{22}$	$3\cdot0_{54}$	$6\cdot3_{3}$	$10\cdot8_{21}$	$10\cdot5_{38}$
1880-7	$4\cdot0_{1}$	$1\cdot4_{44}$	$3\cdot4_{47}$	–	$2\cdot0_{261}$	$6\cdot0_{1}$	$12\cdot1_{6}$	$9\cdot9_{37}$
Mean.	$2\cdot7_{4}$	$1\cdot4_{56}$	$3\cdot8_{70}$	$2\cdot9_{81}$	$2\cdot4_{403}$	$6\cdot2_{235}$	$9\cdot4_{89}$	$9\cdot7_{105}$
Reduced mean.	2·4	1·1	3·3	2·4	2·0	5·2	8·1	8·4

The top line gives the differences between the assumed magnitudes (R Sagittae) for the comparison stars, while below are shown the intervals between them in Baxendell's "steps." The "reduced mean" is obtained by applying the formula of reduction to each comparison individually, in order to convert the "steps" into tenths of a magnitude. There seems to be some probability that the star called *e* is really variable. The Harvard mag. is just brighter than that of *c*, but Baxendell "saw" *e* fainter than *c* 378 times out of 380. Once he saw them equal, and once he made *e* the brighter by 0·1. He also saw *e* usually less than a magnitude brighter than *f* and *g*, though the Harvard values give a difference of 1·3 mags. between *e* and *f*. But the difference between these stars appears to increase almost continuously during these observations. The magnitudes adopted are a compromise between those of Harvard and those suggested by Baxendell's comparisons.

The instruments used were A68 during the first series, and E80 during the second, with the following exceptions. C39 was used 1860, June 27 and Oct. 17 and 20; 1861, Apr. 6 and

29, Sept. 1 and Nov. 7; 1862, July 4 to 24, Aug. 1 and 5, and Sept. 23 and 26; 1863, May 8 and 25, June 12 and 22, July 4 and 8 to 26; Aug. 15, and Sept. 4 and 19; 1864, May 15, and 1869, Nov. 28. R(13)81 was used 1861, May 4 and 9, and 1868, June 18; R(7)39, 1862, July 26 and Aug. 18, and 1863, July 28; and R(7)130, 1863, July 29 to Aug. 13.

TABLE III.

Baxendell's Observations.

Date. 1859	J. D. 240+	Corrected Comparisons.	Deduced Mag.
Oct. 6	0324	93−3, 90−1	90
12	0330	90+2, 93+0	92
15	0333	90+2, 93+0	92
21	0339	90+3, 93+1	94
,,	,,	90+4, 93+1	94
24	0342	93+3, 102−3	98
26	0344	93+4, 102−2, 90+7	98
27	0345	93+4, 102−2, 90+8	98
29	0347	93+4, 102−2, 90+7	98
Nov. 2	0351	90+4, 102−6, 93+0	94
3	0352	93−1, 90+3	92
4	0353	90+2, 93−2	92
6	0355	93−4, 90+0	90
7	0356	90+0, 93−4	90
9	0358	90+0, 93−4, 91−1	90
16	0365	90+0, 93−4	90
20	0369	90+0, 93−4, 91−2	89
24	0373	90+1, 93−3, 91−1	90
28	0377	90+0, 91−1, 93−4	90
30	0379	90+0, 93−3	90
Dec. 1	0380	90+0, 93−3	90
3	0382	90+0, 93−4	90
Dec. 5	0384	90+0, 93−3, 91+0	90
14	0393	90+1, 93−3, 91−1	90
21	0400	90+1, 93−2, 91+0	91
22	0401	90+2, 93−2	92
30	0409	90+4, 93+0, 102−7, 91+2	94
1860			
Jan. 6	0416	93+3, 102−4	97
11	0421	93+3, 102−6	96
17	0427	90+0, 93−4	90
May 9	0540	88+5, 93−3, 91+0	91
17	0548	93−2	91
19	0550	91+1, 93−1	92
June 10	0572	88+3, 93−5	90
18	0580	88+2, 93−3	90
27	0589	88+3, 93−3	90
July 4	0596	88+3, 93−3	90
8	0600	88+1, 93−4	89
12	0604	88+2, 93−4	90
21	0613	88+3, 93−2	91
22	0614	88+3, 93−3	90
24	0616	88+4, 93−2	92
26	0618	88+5, 93−1	92
29	0621	88+6, 93+0	94
30	0622	93+2, 102−6	96
Aug. 4	0627	102+0, 102+0	102

TABLE III.—*Baxendell's Observations of Variable Stars*—continued.

Date. 1860	J.D. 240+	Corrected Comparisons.	Deduced Mag.
Aug. 6	0629	102+2, 102+1	104
31	0654	88−1, 91−2, 93−5	88
Sept. 10	0664	93+0, 88+5	93
13	0667	93−1	92
22	0676	88+5, 93−2	92
25	0679	88+2, 92−3	90
28	0682	88+2, 93−3	90
Oct. 3	0687	91+2, 93−1	92
8	0692	93+2, 102−4	96
11	0695	93+3, 102−3	98
14	0698	93+6, 102−1, 102−1	100
17	0701	102+2, 102+1	104
20	0704	102+3, 102+1	104
21	0705	102+2, 102+1	104
23	0707	102−2, 102−1	100
Nov. 1	0716	88+1, 93−6	88
2	0717	88+0	88
3	0718	88+0	88
5	0720	88+0	88
16	0731	88+2, 93−3	90
18	0733	88+3, 93−2	91
22	0737	88+5, 93−2, 91+1	92
Dec. 18	0763	88+7, 102−4, 93+1	96
20	0765	93+3, 102−3, 102−3, 88+10	98
1861			
Jan. 4	0780	93+1, 102−6	95
6	0782	88+2, 93−3	90
Apr. 6	0872	88+3, 93−3,	90
29	0895	88+3, 91−1, 93−3	90
May 4	0900	88+4, 93−1	92
9	0905	88+6, 93+0	94
17	0913	93+4, 102+0, 102−1	100

Date. 1861	J. D. 240+	Corrected Comparisons.	Deduced Mag.
May 27	0923	88+3, 93−3	90
29	0925	88+2, 93−3	90
June 1	0928	88+1, 93−4	89
13	0940	88+0, 93−7	87
16	0943	88+1, 93−6	88
19	0946	88+3, 93−3	90
25	0952	88+4, 93−3	91
30	0957	88+3, 93−3	90
July 8	0965	88+3, 93−3	90
23	0980	93+3, 102−3	98
26	0983	93+3, 102−3	98
30	0987	93+1, 102−6	95
Aug. 5.	0993	88+2, 93−3, 91−1	90
6	0990	88+1, 93−4	89
16	1004	88+1, 93−5	88
21	1009	88+1, 93−4	89
28	1016	88+2, 93−3	90
30	1018	88+3, 93+0	92
Sept. 1	1020	88+3, 93−1	92
11	1030	88+2, 93−3	90
12	1031	88+2, 93−4	90
20	1039	88+2, 93−4	90
23	1042	88+3, 93−3	90
Oct. 5	1054	93+3, 102−4, 102−5	97
9	1058	93+4, 102−3, 102−3	98
11	1060	93+1, 102−7, 102−7	95
13	1062	88+3, 93−2	91
14	1063	88+3, 93−3	90
16	1065	88+0, 93−5, 91−2	88
19	1068	88−2, 93−6, 91−3	87
22	1071	88−1, 93−5, 91−2	88

TABLE III.—*Baxendell's Observations of Variable Stars*—continued.

Date. 1861	J.D. 240+	Corrected Comparisons.	Deduced Mag.
Oct. 27	1076	88−1, 93−5, 91−3	88
28	1077	88+0, 93−4	88
Nov. 2	1082	88+2, 93−3	90
3	1083	88+1, 93−3, 91+0	90
7	1087	88+3, 93−1	92
11	1091	88+4, 93+1, 91+3	93
15	1095	88+3, 93−1, 91+3	92
17	1097	88+1, 93−3, 91+0	90
27	1107	88+1, 93−4, 91−1	89
30	1110	88+2, 93−3	90
Dec. 3	1113	88+2, 93−3, 91+0	90
21	1131	93+3, 102−5, 102−5	97
25	1135	88+3, 93−2	91
1862			
Apr. 29	1260	88+4, 93−2	92
June 28	1320	88+0, 93−5	88
July 4	1326	88+3, 93−3, 91+0	91
19	1341	88+4, 93+0	92
24	1346	88+0, 93−5	88
26	1348	88+1, 93−4	89
28	1350	93−5, 88−1, 91−2	88
Aug. 1	1354	88+0, 93−5	88
5	1358	88+1, 93−4, 91−1	89
14	1367	88+4, 93−2, 91+1	92
18	1371	88+5, 93+1, 91+4	94

Date. 1862	J.D. 240+	Corrected Comparisons.	Deduced Mag.
Aug. 22	1375	88+4, 93−2, 91+0	91
25	1378	88+2, 93−3, 91+0	90
Sept. 1	1385	88+1, 93−5, 91−2	89
10	1394	88+3, 93−3	90
15	1399	88+5, 93+0, 91+2	93
17	1401	88+6, 93+0, 91+3	94
18	1402	88+6, 102−7, 102−8, 91+3, 93+0	94
20	1404	93+0, 91+3	94
23	1407	91+2, 93+0	93
26	1410	88+3, 93−2, 91−1	91
30	1414	93−4, 91−1, 88+	90
Oct. 4	1418	88+1, 93−5, 91−2	89
8	1422	88+0, 93−5, 91−2	88
18	1432	88+3, 93−3, 91+0	91
24	1438	93+1, 102−7, 91+3	94
29	1443	88+6, 102−7, 93+1	94
Nov. 2	1447	93+0, 91+3	94
10	1445	88+1, 93−5	88
16	1461	88+0, 93−5	88
23	1468	88+2, 93−3, 91−1	90
24	1469	88+3, 93−3, 91+0	91
Dec. 26	1501	88+1, 93−5, 91−3	88

TABLE III.—*Baxendell's Observations of Variable Stars*—continued.

Date. 1863	J. D. 240+	Corrected Comparisons.	Deduced Mag.
Jan. 2	1508	88+7, 102−5, 91+4, 93+1	95
23	1529	88+0, 91−1, 93−5	89
May 8	1634	88+1, 93−4, 91−1	89
23	1649	88+4, 93−1, 91+2	92
25	1651	81+4, 93+0, 91+2	93
June 3	1660	88+6, 93+0, 91+3	94
12	1669	88+3, 93−3, 91+0	91
20	1677	88+3, 93−2, 91+1	91
22	1679	88+4, 93−2, 91+1	92
23	1680	88+5, 93+0, 91+2	93
25	1682	88+5, 93−1, 91+1	92
30	1687	93+1, 91+4	94
July 3	1690	93+3, 102−3, 102−4, 91+5	97
4	1691	93+3, 102−3	98
5	1692	91+2, 93−1	92
8	1695	88+1, 93−4	89
17	1704	88+1, 93−3	90
18	1705	88+1, 93−4	89
26	1713	88+3, 93−2, 91+2	92
28	1715	93+0, 91+3	94
29	1716	93+0	93
31	1718	93+0	93
Aug. 4	1722	93−1	92
Aug. 13	1731	88+2, 93−3, 91−1	90
15	1733	88+2, 93−3	90
24	1742	88+3, 93−2	91
29	1747	88+7, 102−7, 93+0	94
Sept. 3	1752	88+4, 93−1, 91+2	92
4	1753	91+3, 93+0	94
5	1754	93+0, 91+3	94
7	1756	93+1	94
10	1759	93+3, 102−3	98
19	1768	88−1, 93−7	86
22	1771	88+0, 93−7	87
Oct. 9	1788	88+3, 93−2	91
11	1790	93+0, 91+3	94
13	1792	93+2, 102−5	96
24	1803	88+2, 93−3	90
28	1807	88+2, 93−3, 91+1	91
29	1808	88+2, 93−3	90
30	1809	88+1, 93−4, 91−1	89
Nov. 1	1811	88+1, 93−4	89
2	1812	88+1, 93−2	89
6	1816	88+3, *93−2, 91+1	91
9	1819	93+0, 102−7	94
10	1820	93+0, 102−7	94
11	1821	93+1, 91+3	94
19	1829	93+3, 102−4	97
28	1838	88+0, 91−3, 93−6	88
29	1839	88+0	88
Dec. 5	1845	88+2, 93−3, 91−1	90

* The letter e is omitted in the note-book record, and has been supplied conjecturally.

TABLE III.—*Baxendell's Observations of Variable Stars*—continued.

Date.	J. D.	Corrected Comparisons.	Deduced Mag.
1863	240+		
Dec. 17	1857	88+5, 93−1, 91+1,	92
22	1862	93+1	94
27	1867	88+4, 93−2, 91+1	92
1864			
Jan. 1	1872	88+2, 93−3	90
May 15	2007	88+2, 93−4, 91−2	89
16	2008	88+3, 93−3	90
26	2018	88+3, 93−2	91
June 6	2029	88+3, 93−3	90
16	2039	93+6, 102−2, 102−2	100
July 4	2057	88+0	88
8	2061	88+0, 93−6	88
13	2066	88+0, 93−5	88
16	2069	88+0, 93−6	88
19	2072	88+0, 93−5	88
26	2079	88+1, 93−5	88
29	2082	88+1, 93−5	88
Aug. 21	2105	88+4, 93+0	92
23	2107	93+2, 102−4	96
26	2110	93+4, 102−2	98
31	2115	102+0, 102+0	102
Sept. 5	2120	88+3, 93−3	90
9	2124	88+0, 93−5	88
11	2126	88−1, 93−6	87
14	2129	88−1, 93−6	87
19	2134	88+1, 93−4	89
24	2139	88+3, 93−3	90
26	2141	88+3, 93−3	90
Oct. 1	2146	88+3, 93−3	90
3	2148	88+2, 93−3	90
5	2150	88+1, 93−4	89
8	2153	88+3, 93−3	90
17	2162	88+3, 93−3	90

Date.	J. D.	Corrected Comparisons.	Deduced Mag.
1864	240+		
Oct. 24	2169	88+5, 102−7, 93+0	94
31	2176	93+1, 102−7	94
Nov. 5	2181	93+2, 102−4	96
8	2184	88+8, 93+2, 102−6	96
16	2192	88+1, 93−5	88
23	2199	88+1, 93−5	88
1865			
May 18	2375	88+3, 93−3	90
20	2377	88+3, 93−2	91
24	2381	93+0	93
June 8	2396	93+1	94
9	2397	93+1	94
11	2399	88+6, 93−1	93
13	2401	88+3, 93−3	90
17	2405	88+0, 93−4	88
20	2408	88−1, 93−6	87
21	2409	88+0, 93−6	88
26	2414	88+1, 93−5	88
28	2416	88+1, 93−4	89
July 1	2419	88+1, 93−4	89
13	2431	88+3, 93−3	90
14	2432	88+0, 93−5	88
21	2439	88+1, 93−3	90
Aug. 3	2452	88+1, 93−4	89
12	2461	88+8, 102−4, 93+1	96
25	2474	88+0, 93−4	88
31	2480	88+0, 93−4	88
Sept. 7	2487	88+2, 93−3	90
23	2503	88+3, 93−3	90
27	2507	88+3, 93−2	91
Oct. 2	2512	88+2, 93−3	90
7	2517	88+3, 93−2	91
10	2520	88+3, 93−2	91
19	2529	93+2, 102−5, 88+8	96

TABLE III.—*Baxendell's Observations of Variable Stars*—continued.

Date.	J. D.	Corrected Comparisons.	Deduced Mag.
1865	240+		
Oct. 29	2539	93+1, 102−7	94
Nov. 1	2542	88+2, 93−3	90
7	2548	88+1, 93−3	90
12	2553	88+0, 93−5	88
15	2556	88+0, 93−5	88
26	2567	88+3, 93−2	91
Dec. 22	2593	88+3, 93−2	91
31	2602	93+7, 102−2, 102−2	100
1866			
May 17	2739	88+5, 93+1, 102−6	94
20	2742	93+3, 102−3, 88+7	97
22	2744	93+3, 102−3	98
24	2746	93+4, 102−3, 88+9	98
29	2751	88+6, 102−8, 93+0	94
June 8	2761	88−1, 93−7	86
25	2778	88+1, 93−4	89
July 11	2794	88+3, 93−2	91
16	2799	88+3, 93−1, 91+2	92
20	2803	88+4, 93+0	92
22	2805	93+0	93
30	2813	93+5, 102−2, 102−1	100
31	2814	102+0, 102−1	102
Aug. 3	2817	102+0, 102+0	102
20	2834	88+0	88
27	2841	88+1, 93−3	90
31	2845	88+3, 93−2	91
Sept. 8	2853	88+3, 93−3	90
15	2860	88+3, 93−3	90
17	2862	88+3, 93−3	90
Sept. 24	2869	88+5, 93+0, 91+2	93
Oct. 1	2876	93+2, 102−5, 88+7	96
6	2881	93+4, 102−3, 88+9	98
9	2884	88+9, 93+4, 102−3	98
10	2885	93+5, 102−3, 102−3	99
14	2889	93+4, 102−4, 88+9	97
16	2891	93+0, 88+5, 102−8	93
28	2903	88+1, 93−3, 102−10	90
Nov. 3	2909	88+2, 93−3	90
6	2912	88+2, 93−3	90
9	2915	88+5, 93+0	93
11	2917	93+1	94
19	2925	93+1	94
25	2931	88+2, 93−3	90
30	2936	88+3, 93−3	90
Dec. 16	2952	93+3, 102−5	96
30	2966	88+1, 93−3	90
1867			
Jan. 11	2978	91+1, 93−1, 88+5	92
May 21	3108	88+3, 93−2	91
June 29	3147	88+3, 93−1	92
July 24	3172	88+6, 102−6, 93+1	95
27	3175	88+3, 93−2	91
Aug. 1	3180	88+2, 93−3	90
6	3185	88+2, 93−3	90
23	3202	88+4, 93−1	92
Sept. 2	3212	88+4, 93−1	92
10	3220	88+4, 93−2	92

TABLE III.—*Baxendell's Observations of Variable Stars*—continued.

Date.	J.D. 240+	Corrected Comparisons.	Deduced Mag.
1867			
Sept. 16	3226	88+5, 93+1, 91+3	94
24	3234	93+4, 102−3, 102−3	98
25	3235	93+5, 102−3, 102−3	99
27	3237	93+6, 102−2, 102−3	99
Oct. 3	3243	93+1, 102−6, 102−7	95
8	3248	88+0, 93−3	89
17	3257	88+1, 93−4	89
23	3263	88+1, 93−3	90
Nov. 1	3272	88+2, 93−3	90
17	3288	88+3, 93−2	91
19	3290	88+3, 93−2	91
Dec. 6	3307	93+6, 102−2	100
12	3313	93+0, 102−8	94
18	3319	93−5, 88−1	88
1868			
May 20	3473	93+0	93
25	3478	88+3, 93−1	92
June 2	3486	88+3, 93−2	91
4	3488	88+3, 93−3	90
7	3491	88+2, 93−3	90
12	3496	88+2, 93−3	90
15	3499	88−3, 93−3	90
18	3502	88+3, 93−3	90
19	3503	88+3, 93−3	90
25	3509	88+3, 93−1	92
26	3510	88+5, 93+0	93
28	3512	88+4, 93−1	92
29	3513	88+5, 93+0	93
30	3514	93+0	93
July 6	3520	93+0	93
10	3524	88+3, 93−3	90
July 11	3525	88+2, 93−3	90
12	3526	88+1, 93−4	89
13	3527	88+0, 93−5	88
21	3535	88+0, 93−5	88
23	3537	88+0, 93−5	88
25	3539	88+1, 93−4	89
29	3543	88+2, 93−3	90
Aug. 3	3548	88+3, 93−3	90
Sept. 4	3580	88+6, 102−7, 93+1	94
5	3581	93+2	95
6	3582	93+2	95
11	3587	93+2, 88+7, 102−7	95
Oct. 17	3623	88+7, 102−6, 93+3	96
19	3625	93+2, 88+6, 102−5	95
27	3633	88+0, 93−3	89
Nov. 8	3645	88+2, 93−3	90
15	3652	88+3, 93−1	92
1869			
June 8	3857	88+6, 93−1	93
Oct. 26	3997	88+3, 93−2	91
Nov. 28	4030	88+0, 93−5	88
1877			
Dec. 7*	6961	102−2 or 93−2	100 or 91?
17	6971	93−1	92
18	6972	93−1	92
23	6977	93−1	92
31	6985	93−3	90
1878			
June 25	7161	88+2, 91−1	90
28	7164	91−1, 93−2	90
July 7	7173	91+1, 93−2	92

* The letter is g, but Baxendell has added "?e."

TABLE III.—*Baxendell's Observations of Variable Stars*—continued.

Date.	J.D.	Corrected Comparisons.	Deduced Mag.
1878	240+		
July 12	7178	93+3, 102−4	97
20	7186	93+2, 102−6	96
21	7187	93+2, 102−6	96
25	7191	88+0, 91−3	88
27	7193	88+0	88
28	7194	88+0, 91−1	89
Aug. 1	7198	88+0, 91−3	88
4	7201	88+2, 91−1	90
6	7203	88+2, 91−1	90
7	7204	88+3, 91−1	90
8	7205	88+2, 91−1	90
10	7207	88+2, 91+0	90
14	7211	91+1, 88+3	92
18	7215	93+0	93
21	7218	91+2, 93−3	92
25	7222	91+1, 93−2	92
28	7225	88+1, 91−1	90
29	7226	90+0, 91+0	90
Sept. 2	7230	88+0, 91−3	88
5	7233	88+0, 91−3	88
9	7237	88+2, 91−1	90
11	7239	91+1, 88+3	92
13	7241	91+3, 93−2	92
15	7243	91+3, 93−2	92
24	7252	91+3, 102−8	94
Oct. 11	7269	88+1, 91−3	88
13	7271	90+1, 91+0	91
17	7275	91+2, 93−3, 90+3	92
24	7282	93+3, 102−3	98
26	7284	93+3, 102−4	97
27	7285	93+3, 102−4	97
Nov. 1*	7290	93+4, 102−3?	98?
2	7291	93+4, 102−5	97
4	7293	93+3, 102−6	96
8	7297	91+3, 93−1	93
14	7303	91+2, 93−1	92
Nov. 17	7306	91+2, 93−2	92
19	7308	91+3, 93−1	93
28	7317	91+4, 93+1	94
Dec. 4	7323	91+6, 102−8, 93+3	96
5	7324	91+5, 93+2	96
7	7326	91+3, 93−1	93
8	7327	91+3, 93−1	93
23	7342	88+2, 91−2	90
1879			
Jan. 13	7363	93+8, 102+0	102
15	7365	93+6, 102−2	100
19	7369	93+2, 102−7	95
22	7372	88+2, 93−2, 91+1	91
Aug. 1	7563	93+6, 102−1	100
8	7570	93+5, 102−1, 102−2	100
11	7573	102−3, 102−3, 93−6	98
14	7576	91+1, 93−2	92
17	7579	91+1, 93−2	92
21	7583	88+3, 93−3, 91−1	90
23	7585	91+1, 93−1	92
29	7591	93+2, 91+3, 102−8, 102−7	94
31	7593	93+3, 102−7	96
Sept. 2	7595	93+3, 102−7	96
7	7600	91+3, 93+1	94
9	7602	91+4, 93+2	95
12	7605	93+2, 102−4, 102−6, 91+4	96
13	7606	91+4, 93+2, 102−6, 102−6	96
19	7612	93+1, 102−8	94

* The query to the figure 3 is Baxendell's.

TABLE III.—*Baxendell's Observations of Variable Stars*—continued.

Date.	J.D.	Corrected Comparisons.	Deduced Mag.
1879	240+		
Sept. 20	7613	91+1, 93−1	92
21	7614	91+2, 93+0	93
23	7616	91+4, 93+1	94
25	7618	93+2, 102−6, 91+4	95
26	7619	93+2, 102−7	95
28	7621	93+3, 102−6	96
29	7622	91+5, 93+3, 102−7	96
Oct. 2	7625	91+4, 93+2, 102−7	95
4	7627	93+2, 102−7, 91+4	95
5	7628	93+3, 102−6, 91+5	96
6	7629	93+4, 102−6, 91+6, 102−6	96
14	7637	93+8, 102−1, 102−1	101
15	7638	102−1, 102−2	100
16	7639	102−1, 102−2	100
17	7640	102−1, 102−1	101
20	7643	93+7, 102−3, 102−3	99
25	7648	91+1, 93−1	92
26	7649	91+2, 93+0	93
28	7651	91+2, 93+0	93
Nov. 1	7655	91+1, 93−0	92
2	7656	91+1, 93−1	92
5	7659	91+1, 93−1	92
10	7664	91+4, 93+2, 102−7	95
12	7666	91+3, 93+1	94
13	7667	93+1	94
22	7676	91+3, 93+1	94
Nov. 23	7677	91+3, 93+1	94
24	7678	91+2, 93+0	93
25	7679	91+2, 93+0	93
27	7681	93+0	93
29	7683	93+0	93
30	7684	93+0	93
Dec. 3	7687	93+0	93
6	7690	93+0	93
22	7706	91+7, 93+5, 102−4, 102−4	98
23	7707	91+8, 102−3, 102−4, 93+6	99
24	7708	91+8, 93+5, 102−4, 102−5	98
26	7710	91+8, 102−5, 102−6, 93+6	98
28	7712	91+7, 102−7, 93+4, 102−6	96
1880			
Jan. 2	7717	90+1, 93−1, 91+1	92
3	7718	92+2, 93−1, 90+2	92
Mar. 17	7792	91−3, 93−4, 90−1	89
Apr. 17	7823	93−4	89
24	7830	90+0, 91−2	90
29	7835	91+1, 93−1	92
30	7836	91+0, 93−2	91
May 5	7841	91+0, 93−2	91
7	7843	91+1, 93+0	92
12	7848	93+3, 102−4	97
13	7849	93+4, 102−4	98
15	7851	93+5, 102−3	98
16	7852	93+4, 102−3	98
19	7855	93−1, 91+0	92
27	7863	90+1, 91−2, 93−3	90

TABLE III.—*Baxendell's Observations of Variable Stars*—continued.

Date. 1880	J.D. 240+	Corrected Comparisons.	Deduced Mag.
May 28	7864	90+1, 93−3	90
29	7865	90+1, 93−3	90
June 4	7871	90+1, 93−3, 91−1	90
7	7874	80+1, 93+3, 91−1	90
8	7875	90+1, 93−2, 91−1	91
9	7876	90+1, 93−2, 91−1	91
17	7884	90+1, 93−2, 91+0	91
18	7885	90+1, 93−3, 91−1	90
19	7886	90+1, 93−2, 91−1	91
26	7893	90+1, 91−1, 93−3	90
July 3	7900	90+1, 93−3, 91−1	90
4	7901	90+1, 93−2, 91+0	91
9	7906	90+2, 93−1, 91+1	92
20	7917	93+8, 102−1, 91+10, 102−2	101
29	7926	91+1, 93−2	92
30	7927	90+1, 93−2, 91+0	91
31	7928	91+0, 93−2	91
Aug. 6	7934	90+0, 93−3, 91−1	90
9	7937	93−3, 91−1	90
11	7939	93−3, 91−1	90
12	7940	90+0, 93−3, 91−1	90
13	7941	93−3, 91−1	90
14	7942	90+0, 91−1, 93−3	90
Aug. 16	7944	93−3, 91−1	90
17	7945	93−2, 91−1	90
22	7950	90+0, 93−3, 91−1	90
24	7952	90+0, 93−3, 91−1	90
27	7955	90+1, 93−2, 91+0	91
28	7956	90+1, 91+0, 93−2	91
29	7957	90+1, 93−2, 91−1	91
30	7958	90+2, 93−2, 91+0	91
31	7959	90+2, 93−2, 91+0	91
Sept. 2	7961	90+0, 93−3, 91+0	90
3	7962	90+0, 93−2, 91−1	90
4	7963	90+1, 93−3, 91−1	90
7	7966	90+0, 93−2, 91+0	91
8	7967	90−1, 93−2, 91+0	90
13	7972	90+0 93−2, 91+0	91
15	7974	93−2, 91+0	91
16	7975	90+1, 93−2, 91+0	91
18	7977	91+0, 90+1, 93−2	91
20	7979	90+2, 93−1, 91+0	92
25	7984	93+0, 91+2	93
26	7985	91+3, 93+1	94
27	7986	93+4, 102−3	98

TABLE III.—*Baxendell's Observations of Variable Stars*—continued.

Date.	J. D.	Corrected Comparisons.	Deduced Mag.
1880	240+		
Sept. 28	7987	93+6, 102−3	99
Oct. 2	7991	93+6, 102−3	99
3	7992	93+6, 102−2	100
9	7998	91+2, 93+0	93
10	7999	91+0, 93−2	91
11	8000	90+1, 93−2, 91+0	91
17	8006	90−1, 91−2, 93−3	89
20	8009	93−3, 91−1, 90−1	90
23	8012	91−1, 93−3	90
29	8018	93−3, 91−1	90
31	8020	91+0, 93−2	90
Nov. 3	8023	93−2, 91+0	91
8	8028	91+1, 93−1	92
19	8039	91+0, 93−3	90
20	8040	93−3, 91−1	90
26	8046	91+1, 93−1	92
27	8047	91+2, 93+0	93
Dec. 1	8051	91+1, 93−1	92
4	8054	91+2, 93+0	93
18	8068	91+3, 93+0	94
24	8074	91+0, 93+2	91
1881			
Jan. 12	8093	91+2, 93−1	92
Apr. 23	8194	90+2, 91+0, 93−3	91
May 4	8205	91+0, 93−2	91
7	8208	93+0, 90+3	93
9	8210	93−1, 91+0	92
12	8213	91−1, 93−3	90
16	8217	93−3, 91−1	90
20	8221	91−1, 93−3	90
21	8222	91−1, 93−3	90
22	8223	91+0, 93−2	91
23	8224	93−3, 91−1	90

Date.	J. D.	Corrected Comparisons.	Deduced Mag.
1881	240+		
May 29	8230	91−1, 93−2	90
30	8231	91+0, 93−2	91
June 8	8240	91+0, 93−2	91
12	8244	91+1, 93−1	92
18	8250	90+0, 93−3, 91−1	90
27	8259	93−3, 91−1	90
July 8	8270	91+3, 93+2	94
11	8273	93+2, 102−7	95
14	8276	93−2, 91+0	91
17	8279	90+0, 93−3	90
19	8281	93−3, 91−1	90
27	8289	93−3, 91−1	90
Aug. 1	8294	93−2, 91+0	91
5	8298	93−3, 91−1	90
6	8299	93−2, 91+0	91
24	8317	93−3, 91−1	90
31	8324	93−2, 91+0	91
Sept. 1	8325	93−3, 91−1	90
14	8338	91+2, 93+0	93
16	8340	91+2, 93+0	93
19	8343	91+2, 93+0	93
25	8349	91+0, 93−2	91
Oct. 1	8355	90+0, 93−3, 91−1	90
2	8356	90+0, 93−3, 91−2	90
8	8362	93−3, 91−1	90
15	8369	93−3, 91−1	90
16	8370	93−2, 91−0	91
26	8380	91+2, 93−1	92
29	8383	93−2, 91+0	91
Nov. 5	8390	93−3, 91−1	90
14	8399	93−2, 91+0	91
17	8402	93+1, 91+3	94
20	8405	91+3, 93−1	93
22	8407	91+2, 93+0	93
28	8413	91+7, 93+5, 102−3	98

TABLE III.—*Baxendell's Observations of Variable Stars*—continued.

Date.	J. D.	Corrected Comparisons.	Deduced Mag.
1881	240+		
Dec. 1	8416	93+7, 102−3, 91+8	99
10	8425	91+1, 93−2	92
19	8434	91+0, 93−2	91
1882			
May 12	8578	91+1, 93−1	92
14	8580	91+0, 93−1	92
16	8582	91−0, 93−1	92
18	8584	93−2, 91+0	91
19	8585	91+0, 93−1	92
20	8586	91+0, 93−1	92
25	8591	91+1, 93−1	92
28	8594	91+0, 93−2	91
29	8595	91+0, 93−2	91
June 30	8627	93+7, 102−2, 102−3	100
July 9	8636	91+0, 93−2	91
24	8651	93−2, 91+0	91
26	8653	91+1, 93−2	92
29	8656	93−2, 91−1	90
Aug. 19	8677	93−2, 91+0	91
Sept. 4	8693	91+1, 93−1	92
9	8698	91+1	92
11	8700	91+2, 93+0	93
13	8702	91+3, 93+2	94
15	8704	91+0, 93−2	91
Oct. 5	8724	91+3, 93+1	94
28	8747	91+0, 93−2	91
1883			
July 28	9020	91+2, 93+1	94
Aug. 25	9048	91+2, 93+0	93
Oct. 28	9112	91−1, 93−2	90
1884			
May 18	9315	91+0, 93−2	91
24	9321	91−1, 93−3	90
26	9323	91+0, 93−2	91
May 27	9324	91+0, 93−2	91
30	9327	91+0, 93−2	91
June 11	9339	93−3, 91−1	90
12	9340	91−2, 93−3	90
20	9348	93−3, 91−1	90
25	9353	93−3, 91−1	90
29	9357	93−3, 91−1	90
July 2	9360	93−2, 91−1	90
7	9365	91+2, 93+0	93
12	9370	91+3, 83+1	94
16	9374	93+3, 102−7	96
19	9377	91+1, 93−1	92
23	9381	91+0, 93−3	90
25	9383	93−2, 91−1	90
27	9385	93−3, 91−1	90
Aug. 1	9390	93−3, 91−1	90
4	9393	93−2, 91−1	90
6	9395	93−3, 91−1	90
11	9400	93−2, 91−1	90
14	9403	91+0, 93−1	92
15	9404	93−1	92
18	9407	91+0, 93−1	92
23	9412	93−2, 91−1	90
25	9414	91+0, 93−1	92
30	9419	91+2, 93+1	94
Sept. 1	9421	91+1, 93−1	92
4	9424	93−3, 91−1	90
11	9431	91+1, 93−1	92
12	9432	91+1, 93+0	92
13	9433	91+2, 93+0	93
16	9436	91+3, 93+1	94
17	9437	91+2, 93+1	94
19	9439	91+4, 93+3, 102−6	96
20	9440	91+3, 93+2	94
24	9444	91+4, 93+2	95
26	9446	91+4, 93+3, 102−6	96

TABLE III.—*Baxendell's Observations of Variable Stars*—continued.

Date. 1884	J. D. 240+	Corrected Comparisons.	Deduced Mag.
Sept. 29	9449	91+5, 93+3, 102−6	96
Oct. 4	9454	91+0, 93−2	91
5	9455	91−1, 93−3	90
9	9459	93−3, 91−3	89
12	9462	93−3, 91−2	90
Nov. 7	9488	91+0, 93−2	91
13	9494	91+0, 93−2	91
17	9498	91+0, 93−1	92
19	9500	91+1, 93+0	92
21	9502	91+0, 93−2	91
27	9508	91+3, 93+0	94
28	9509	91+6, 102−7, 93+3	96
29	9510	93+7, 102−3, 102−3	99
Dec. 3	9514	91+8, 102−2, 93+7, 102−1	100
4	9515	93+7, 102−1, 91+9, 102−3	100
6	9517	91+9, 102−1, 93+7	100
8	9519	93+6, 102−3, 102−6	98
9	9520	93+3, 102−6, 91+4	96
11	9522	91+2, 93−1	92
14	9525	91+1, 93−3	91
15	9526	91−1, 93−3	90
20	9531	91−3, 93−4	88
21	9532	93−5, 91−3	88
24	9535	93−5, 91−3	88
1885			
Jan. 5	9547	91+0, 93−2	91
8	9550	91+2, 93+0	93
11	9553	93−2	91
14	9556	91+1, 93−1	92
Apr. 29	9661	93+4	97

Date. 1885	J. D. 240+	Corrected Comparisons.	Deduced Mag.
May 7	9669	91−2, 93−3	90
11	9673	93−1, 93−3	90
20	9682	91+0, 93−2	91
June 1	9694	91+1, 93−1	92
9	9702	91+0, 93−2	91
12	9705	93−3, 91−1	90
July 4	9727	91+1, 93−1	92
9	9732	93+0	93
25	9748	91+0, 93−1	92
28	9751	93−2, 91−1	90
Aug. 1	9755	93−2, 91+0	91
3	9757	93−3, 91−1	90
14	9768	93−2, 91+0	91
16	9770	93−2, 91+0	91
18	9772	93−2, 91−1	90
19	9773	93−2, 91−1	90
20	9774	93−2, 91+0	91
22	9776	93−3, 91−1	90
28	9782	93−2, 91+0	91
Sept. 3	9788	93+0, 91+1	92
5	9790	91+3, 93+2, 102−8	94
6	9791	91+4, 93+3	96
7	9792	21+3, 93+2	94
8	9793	91+5, 93+3	96
9	9794	91+7, 93+5, 102−1	99
12	9797	91+7, 93+5, 102−1	99
13	9798	91+7, 102−1, 93+5	99
14	9799	102+0, 93+6, 91+8	100
18	9803	93+6, 102−1, 91+9	100
21	9806	91+2, 93+0	93
25	9810	91−1, 93−3	90
26	9811	91−1, 93−3	90

TABLE III.—*Baxendell's Observations of Variable Stars*—continued.

Date.	J. D.	Corrected Comparisons.	Deduced Mag.
1885	240+		
Sept. 27	9812	91 − 1, 93 − 3	90
Oct. 7	9822	91 − 1, 93 − 3	90
29	9844	91 + 0, 93 − 1	92
Nov. 8	9854	91 + 1, 93 + 0	92
15	9861	93 + 0, 91 + 2	93
19	9865	93 + 6, 102 − 3	99
28	9874	93 + 3, 102 − 5	96
Dec. 1	9877	91 + 2, 93 + 0	93
26	9902	91 − 1, 93 − 2	90
1886			
Jan. 5	9912	93 − 2, 91 + 0	91
11	9918	91 + 0, 93 − 1	92
May 21	241+0048	91 + 1, 93 + 0	92
29	0056	93 − 2, 91 + 0	91
June 5	0063	91 + 0, 93 − 1	92
14	0072	91 + 2, 93 + 0	93
26	0084	91 + 0, 93 − 2	91
30	0088	93 − 2, 91 + 0	91
Sept. 14	0164	91 − 1, 93 − 3	90
17	0167	93 − 3, 91 − 1	90
Oct. 23	0203	91 + 0, 93 − 1	92

Date.	J. D.	Corrected Comparisons.	Deduced Mag.
1886	241+		
Oct. 25	0205	91 + 0, 93 − 1	92
30	0210	91 + 0, 93 − 1	92
Nov. 2	0213	91 + 1, 93 + 0	92
4	0215	91 + 3, 93 + 0	94
7	0218	93 + 6, 102 − 2	100
9	0220	93 + 6, 102 − 3	99
10	0221	93 + 6, 102 − 2	100
13	0224	93 + 3, 102 − 5	96
15	0226	93 + 1, 102 + 6	95
16	0227	91 + 0, 93 − 1	92
17	0228	91 + 0, 93 − 2	91
18	0229	91 − 1, 93 − 2	90
30	0241	93 − 4, 91 − 2	89
Dec. 4	0245	93 − 3, 91 − 1	90
16	0257	91 + 1, 93 + 0	92
20	0261	93 − 2, 91 + 0	91
25	0266	93 − 3, 91 − 1	90
29	0270	91 + 0, 93 − 2	91
1887			
Jan. 12	0284	91 + 4, 93 + 2	95
June 10	0433	102 + 0	102

When the observations have been tabulated in the usual manner, with an assumed period of 70·5 days, it becomes evident (1) that there is very little variation in the length of period; (2) that the *shape* of the curve varies so greatly that no "mean curve" can possibly be properly deduced from the whole of the observations, nor even from any considerable number of consecutive periods. The changes in the form of the curve are, however, not so rapid but that two or three consecutive periods are usually more or less of the same type. The many gaps in almost every period make it undesirable to take the mean of the "portions" in forming a combined curve for 2 or 3 periods, for (owing to the fact of there being two maxima and two minima in each period) the changes in mag. are very rapid, and at the same time relatively so small that they may be sometimes swamped by accidental errors. The shortness of the period makes these gaps more serious, as a blank of 10 or 12 days may mean the total loss of two "portions" of the curve. For these and other reasons gaps in the observations cannot safely be filled in conjecturally in tabular form. The

observations have therefore been plotted individually on squared paper, first all singly, and then with the 2 or 3 consecutive periods observed in a single season super-imposed on each other. This gives 18 curves, each formed from sets of observations extending over from 103 to 257 days; and it was found comparatively easy to draw a smooth curve through each of them by the eye; though in a few cases where the type of curve is changing rapidly the result is rather confused. A few isolated observations or groups of observations were omitted, and, in some cases, the first few or last few observations of a series were left out in order to bring the desired "epoch" as nearly as possible into the centre of the set.* These curves are of three distinct types, with minor variations. In the "A" type, the primary minimum (as it is called for convenience) is much deeper than the secondary one, and the primary maximum (which follows closely on the primary minimum) is higher than the secondary one. In the "B" type, the two minima are nearly (sometimes quite) equal, and so are the two maxima. In the "C" type, the secondary minimum is much deeper than the primary, and the secondary maximum equals or exceeds the primary one in brightness.

The mag. at maximum varies very little in different periods, but that at minimum varies by more than a magnitude, both in the primary and secondary minimum. A slight variation in length of period was obvious from inspection, but corrections to epoch could not be obtained quite in the usual manner, owing to the absence of a general mean curve. But the 18 curves already mentioned were classified as of the "A," "B," and "C" type, and three different mean curves were then obtained from them; from each of which (when plotted) the places of primary and secondary minimum and maximum were read off as carefully as possible. Table IV. gives the magnitude for twelve about equidistant points in each of these mean curves, and the place of primary and secondary minimum for each, in days after the initial date in each case. The epochs of minimum are given, instead of those of maximum, because the maxima are generally much flatter than the minima, and are therefore more difficult to judge. It is a question whether they may not be really actually flat for a few days.

* In one case a few observations at each end were omitted as the length of time covered seemed too long for one curve.

TABLE IV.

TABLE IV. (unit 0·01 mag.).

Type.	(1.)	(2.)	(3.)	(4.)	(5.)	(6.)	(7.)	(8.)	(9.)	(10.)	(11.)	(12.)	Primary minimum.	Secondary minimum.
A	901	912	910	904	906	920	946	985	966	902	884	890	49	14
B	940	938	914	900	907	924	942	941	907	894	903	923	44	8¾
C	978	921	900	899	904	914	917	908	904	907	916	939	41	5½

A good deal of "trial and error" work led to the hypothesis that the *principal type is B* and that A deviates about as much on one side of it as C on the other, as far as the form of the curve is concerned. But the maxima and minima in C (as given in Table IV.) are 2 or 3 days behind those in B, and those in B are 5 days behind those in A. As the differences in phase in these cases are *means* only, and the phases differ as much between individual curves of the same type as between the types, they seem to have no connection with the differences in form; so fresh readings have been taken from the A and C typical curves, starting at such points as will bring the maxima and minima of all three curves as nearly as possible together, and, on the suggested hypothesis, B should be intermediate between A and C, as so placed.

A=912	911	905	904	916	940	980	975	908	884	888	899
C=966	953	908	898	900	910	916	915	906	906	912	927
½(A+C)=939	932	907	901	908	925	948	945	907	895	900	913
B=940	938	914	900	907	924	942	941	907	894	903	923
B−½(A+C)=+1	+6	+7	−1	−1	−1	−6	−4	0	−1	+3	+10

These differences in units of 0·01 are small, and (although there is an appearance of system about them) it seems worth while trying whether they may be treated as accidental. The two curves, B and ½(A+C), run very closely together, being coincident in phase, and differing very slightly in magnitude. Hence we may derive the best curve for B by taking means between B and ½(A+C), as follows:—

940 935 910 900 907 924 945 943 907 894 902 918

This is very nearly symmetrical, as we may see by writing twice over

940	935	910	900	907	924
945	943	907	894	902	918
Diff. +5	+8	−3	−6	−5	−6

The mean curve, if twice repeated, would be

939 909 897 905 921

And the following terms represent an exact harmonic, of 2 waves.

$\sin 2\theta$	0	+5	+5	0	−5	−5
$\cos 2\theta$	+22	+11	−11	−22	−11	+11
$\sin 4\theta$	0	+3	−3	0	+3	−3
$\cos 4\theta$	+1	0	0	+1	0	0
Constant	919	919	919	919	919	919
Sum (calc.)	942	938	910	898	906	922
Obs.—Calc.	+1	+1	−1	−1	−1	−1

which are quite negligible.

Hence let us adopt as the B type the calculated form

942 | 938 | 910 | 898 | 906 | 922 | 942 | 938 | 910 | 898 | 906 | 922

Then

$A-B_0=$	−30	−27	−5	+6	+10	+18	+38	+37	−2	−14	−18	−23
$C-B_0=$	+24	+15	−2	0	−6	−12	−26	−23	−4	+8	+6	+5

Comparing the two we get the following differences

−6 −12 −7 +6 +4 +6 +12 +14 −6 −6 −12 −18

which are not very large and are obviously due to the fact that C does not really differ quite so much from B in one direction as A does in the other. The average value of $(A-B_0)/(A-C)$ is a little more than $\frac{5}{8}$, and the residuals are in most cases quite small; so it seems best to make the calculated A and C curves differ from B_0 in that ratio. The simplest method of getting them is by analysing A—C. We thus get

$$+6\sin\theta - 46\cos\theta + 3\sin 2\theta + 7\cos 2\theta.$$

The 2nd harmonic is not quite negligible, although so small (the unit being 0·01 mag.) that it may easily be spurious. If it be real, the disturbance of the B_0 type is not merely a wave of period 70·5 days, but includes a disturbance of the 35·3 period also. Comparing this expression with the observations, we have the residuals (obs.—calc.) :—

−15 −11 +15 +7 −6 −13 +11 +17 −16 −9 +10 +15

These residuals are clearly systematic, and show that a 3rd harmonic is required. This is found to be

$$-12\sin 3\theta - 12\cos 3\theta$$

and we then obtain the following residuals :—

−3 +1 +3 −5 +6 −1 −1 +5 −4 +3 −2 +3

These residuals being negligible, we can proceed to compare the observed typical curves with the calculated ones, forming the latter by adding $\frac{5}{8}(A-C)$ to B_0 for A, and subtracting $\frac{3}{8}(A-C)$ from B_0 for C, using the calculated A—C in each case.

A (calc.) =	910	911	906	905	912	941	983	972	914	882	892	903
A (obs.) =	912	911	905	904	916	940	980	975	908	884	888	899
Obs.—Calc. =	+2	0	−1	−1	+4	−1	−3	+3	−6	+2	−4	−4
C (calc.) =	963	954	912	894	902	910	918	917	908	907	914	934
C (obs.) =	966	953	908	898	900	910	916	915	906	906	912	927
Obs.—Calc. =	+3	−1	−4	+4	−2	0	−2	−2	−2	−1	−2	−7
B (calc.) =	942	938	910	898	906	922	942	938	910	898	906	922
B (obs.) =	940	938	914	900	907	924	942	941	907	894	903	923
Obs.—Calc. =	−2	0	+4	+2	+1	+2	0	+3	−3	−4	−3	+1

These residuals are again quite small, not amounting in any case to 0·1 magnitude, so that it seems quite worth while to adopt the calculated typical curves in place of the observed ones, and to proceed to compare the individual curves with them.

[*Note.*—It might be thought that $\frac{1}{2}(A+C)$ having been used in obtaining B_0 might have made the latter come out incorrectly, as A and C are not equidistant from it. But the observed A and C differ in the ratio of 3 to 2 from the observed B, and if we take the mean of $\frac{1}{5}(3C+2A)$ and B, to form B_0, we get 941 938 909 898 905 921, which is in even closer agreement with the calculated B than was the originally obtained B_0.]

Having thus obtained the three typical curves, it was possible to compare 17 of the 18 separate curves with them, taking the magnitude at each of the 12 points. (One curve was too scantily observed to be of use.) The resulting corrections to a mean epoch are shown in Table V. As both editors independently found the same general correction to the mean period, making it 70·53 days, that period has been adopted in the Table, instead of the period of 70·5 days first assumed. As the two minima and maxima do not seem to hold always the same relative positions, corrections have been taken separately for each, using one part of the curve for the primary minimum and the other part for the secondary one, and these corrections have been applied instead of the mean correction got from the whole curve. In the A type, the primary part has very much the greater weight by $p-f$, and in the C type the secondary part; in B of course the weights are equal. The places* of these two minima in

* These places are, in the A curve, 9·8 and 43·5 days after the starting point; in B, 8·35 and 43·6 days; and in C, 8·1 and 44·4. Remembering that in the A curve the starting point has been advanced by 5 days, and in the C curve put back 3 days, it will be seen that these points are in pretty good agreement with those read from the observed curves, given in Table IV., but the distances Prim.—Sec. differ rather more in the different types.

the typical curves have been found by calculation, and the corrections to the mean epochs thus shown have been added to those obtained by comparing the individual curves with the typical ones. The "mean" position is that shown by the B calculated curve.

TABLE V.

Corrections to Epoch (*unit* 0·01 *mag.*).

Period.	Type.	Mean primary minimum.	Corrections. To pri.	Corrections. To sec.	Distance between pri. and sec.	Date of prim. min.	Date of sec. min.
		240+			°		
I.	A	0344·0	+1·8	+2·3	177·1	0345·8	0311·1
V.	,,	0626·1	+2·8	+5·2	167·4	0628·9	0596·1
X.	,,	0978·8	+4·6	+9·2	156·2	0983·4	0952·8
XVI.	B	1402·0	+5·4	+6·6	173·6	1407·4	1373·4
XXI.	B (A)	1754·6	+3·8	+3·5	181·3	1758·4	1722·9
XXVI.	A	2107·3	+3·9	+6·5	166·4	2111·2	2078·6
XXXI.	,,	2459·9	+2·6	+3·0	177·6	2462·5	2427·7
XXXVI.	,,	2812·6	+1·2	−1·3	192·5	2813·8	2776·1
XLII.	,,	3235·7	+0·4	−0·4	183·8	3236·1	3200·1
XLVI.	B	3517·9	−1·8	−1·9	181·5	3516·1	3480·8
XCIX.	B	7255·9	−8·0	−4·8	162·9	7247·9	7215·9
CIV.	B (C)	7608·6	−7·3	−9·6	190·8	7601·3	7563·8
CIX.	C	7961·2	−3·8	−4·8	183·5	7957·4	7921·2
CXIV.	,,	8313·9	−4·0	−4·5	181·0	8309·9	8274·2
CXXX.	A	9442·4	+1·5	+0·4	185·2	9443·9	9407·6
CXXXV.	,,	9795·0	+2·1	+0·8	186·2	9797·1	9760·6
CXLI.	,,	10218·2	+2·1	+2·2	179·1	0220·3	0185·2

Mean of first three	166·9
,, of next four	174·7
,, of next three	185·9
,, of next four	179·6
,, of last three	183·5

In reckoning the distance in degrees, the apparent length of the period for the time being (which varies from 70 to 71 days) has been taken into account.

When the corrections to the Primary epoch are plotted on squared paper, they strongly suggest a periodic variation with a cycle of about 131 periods, and an amplitude of about 7 days. They can also be fairly represented by a discontinuity solution in 3 lines. The formula which suits them best is :—

$$2408522{\cdot}8+70{\cdot}53E'+7 \sin 2^{\circ}{\cdot}7E'$$

Chandler's formula for the primary maximum was

$$2400358{\cdot}5+70{\cdot}56E+6{\cdot}5 \sin (2^{\circ}{\cdot}25E+47^{\circ})$$

and the correlation formulae—*M. N.*, lxviii. p. 551—would give a term

$$11{\cdot}8 \sin (3^{\circ}{\cdot}9E+?).$$

In Table VI., the observed epochs are compared with the above formula (F), and with the discontinuity solution (D):—

Period		I.	0347·3	Length of period.
				70·6
,,		XXII.	1829·9	
				70·3
,,		LXXXIX.	6540·0	
				70·8
,,		CXLI.	0221·6	

There is a single observation, J. D. 2410433·5, giving magnitude 10·2, which is very rarely reached in any other minimum, so that we may regard this as being *approximately* the epoch of primary minimum for period CXLIV.

TABLE VI.

Comparisons of Epochs of Minimum.

Period.	Type.	E[1]	No. of obsns.	No. of periods used.	Primary minimum (Bax.)	B−F.	B−D.	*Chandler.	B−Ch.
I.	A	−116	30	2	0345·8	−0·8	−1·5	0348·3	−2·5
V.	,,	−112	38	3	0628·9	−0·5	−0·8	0631·2	−2·3
X.	,,	−107	47	3	0983·4	+0·7	+0·7	0984·5	−1·1
XVI.	B	−101	29	2	1407·4	+1·1	+1·1	1408·3	−0·9
XXI.	B(A)	− 96	52	3	1758·4	−0·4	−0·9	1761·2	−2·8
XXVI.	A	− 91	31	3	2111·2	+0·2	+0·1	2113·8	−2·6
XXXI.	,,	− 86	33	3	2462·5	−0·3	−0·1	2466·2	−3·7
XXXVI.	,,	− 81	33	3	2813·8	−0·4	−0·3	2818·4	−4·6
XLII.	,,	− 75	20	2	3236·1	+0·4	+0·2	3240·7	−4·6
XLVI.	(A)B	− 71	28	1½	3516·1	−0·5	−1·0	3522·1	−6·0
XCIX.	B	− 18	45	2½	7247·9	−0·1	−0·1	7251·9	−4·0
CIV.	B(C)	− 13	56	2	7601·3	−0·6	−0·7	7604·8	−3·5
CIX.	C	− 8	69	3	7957·4	+1·4	+1·4	7959·9	−2·5
CXIV.	,,	− 3	47	3	8309·9	−0·3	−0·1	8313·2	−3·3
CXXX.	A	+ 13	62	3	9443·9	+0·2	+1·1	9443·2	+0·7
CXXXV.	,,	+ 18	44	3	9797·1	−0·5	+0·3	9797·2	−0·1
CXLI.	,,	+ 24	22	1½	0220·3	−1·5	−1·3	0222·1	−1·8
CXLIV.	?A	+ 27	1	...	(0433·5)	(−0·2)	(−0·5)	0434·6	(−1·1)

* Chandler's formula is meant for the primary max.: 15 days have therefore been subtracted from his epochs for the A and B types, and 13 days for the C types, these being the intervals shown in the three typical curves. This column shows clearly a systematic, though small, difference from Baxendell.

The question whether the new formula, or the discontinuity solution, or something else, is the true method of variation, must be determined by reference to other and later observations. Mr. Van der Bilt is at the present time preparing a discussion on this star, using a large number of later observations to which we have not access; and the publication of his conclusions will no doubt throw new light on the matter. As far as Baxendell's observations go, the following additional details may be given here. An isolated group of observations at $E' = -68\frac{1}{2}$ shows that the secondary min. is there getting deeper, and is probably at least as deep as the primary one, so that the type is most likely B, and very possibly it may go on to C, during the long gap in the observations which follows. Another group of 4 observations at $E' = -16\frac{1}{2}$ shows that the secondary min. is there becoming very deep—it was already much deeper at $E' = -17\frac{1}{2}$ than at $E' = -18\frac{1}{2}$,—so that the type is there approaching rapidly to that of C. The primary minimum indicated by the final isolated observation (J. D. 1433·5) is so deep that the type is almost certainly A. The A type prevails from 2400320 to 1140 (where it is beginning to approach B); B from 1320 to about 1750 (when it begins to change to A); A again till 3320 (at least); B from 3470 or earlier to 3650 or later. After the long gap, the B type prevails, with a tendency towards C, until about 7650, after which it becomes definitely C, and continues so until (probably) about 8700. Then another gap (except for a few isolated obsns.) intervenes; and when the observations become frequent again, after 9315, we find that the A type has returned (though, at first, with rather shallow primary minima), and it continues to the end. There are probably some B type periods between 8700 and 9300.

There appears to be also a long-period variation in general brightness which cannot be definitely systematised from these observations. It has a well-marked min. at apparently about J. D. 2407620, and there is a certain appearance of a tendency for the same form of curve to repeat itself about every 16 periods, or 1128 days. With a view to testing this idea, all the observations were tabulated for 24 "portions" in each period, the periods were arranged in sets of 16 consecutively, and the means taken for all the portions of all the sets, placed one above another. The resulting means, when plotted, gave a very well marked curve of general brightness, with its min. at J. D. 7620 (and of course at all intervals of 1128 days and multiples thereof from that date); and its max., not quite so well marked, at about 8 periods', or 564 days' distance from the minimum. This gave only two dates besides 7620, which were actually observed, for min., viz. 8748 and 9876, and the latter comes just at the end of a set of observations. For max., the dates included in actually observed periods would be 1416, 2544 and 9312, the last just at the beginning of a set of observations. Now there is no very marked appearance of a max.

at any of these dates; and as regards the dates for min., 9876 is possible, but 8748 looks more like a possible maximum. Also 2410440, which would be another date for the max., is a rather unlikely one, the mag. at 0333 being so low. These facts, and certain rather striking discrepancies in detail which were observed in taking the means, lead to the idea that the real period might be *double* the 1128 days. This would give dates for min. at 0852, 3108, 7620, and 9876, which are all possible ones, though the two first are not actually observed. The dates for max. would be 1980 and 8748, besides others quite unobserved. These two dates are possible ones, though neither is *properly* observed. The fact of no max. being really observed would account for the min. being well marked in the curve obtained, as there was practically nothing to modify it at all seriously; while the mean parts of the true curve would naturally appear as a less well defined max. The observations were therefore re-arranged in sets of 32 periods; but the result was entirely to negative this idea. The curve obtained showed *two* minima and maxima; one min. as before at 7620, etc., and the other rather more than 16 periods after it. This suggests a possible range of more than 16 periods, so an arrangement of 17 was tried, in which the min. at 7620, etc., was again conspicuous, and a less marked max. followed it at less than $8\frac{1}{2}$ periods' distance. As one-eighth of the variation period represented by the formula suggested on page 679 is $16\frac{2}{3}$ periods, this was next tried, but without any trustworthy results. In each of the previous attempts, the sets consisted of complete periods of 70·5 days, one under another, and the primary and secondary maxima and minima came out clearly and sharply in every place, right through, so that they could be completely allowed for; but in this new attempt, they were partly masked, yet (owing to the many long gaps) so imperfectly that their effect could not be judged, and they would have vitiated any supposed conclusions. Another plan was therefore tried. The values in magnitudes for the 12 points in each of the 17 curves were translated into brightness, taking mag. 10·5 as unit, and then the mean brightness was obtained for each curve, from the sum of the 12 points. The following is the result, in figures, taking the brightness at mag. 9·1 as mean :—

TABLE.

Period.	Mean brightness.	Mean J. date of observations.
		240+
I.	+0·00	0375
V.	−0·29	0638
X.	+0·04	0993
XVI.	+0·13	1405
XXI.	−0·12	1760
XXVI.	+0·19	2114
XXXI.	+0·11	2471
XXXVI.	−0·26	2832
XLII.	−0·33	3243
XLVI.	+0·13	3530
XCIX.	−0·21	7257
CIV.	−0·97	7640
CIX.	−0·17	7955
CXIV.	−0·18	8314
CXXX.	−0·25	9448
CXXXV.	−0·36	9789
CXLI.	−0·28	10224

It is at once easy to see why the minimum at about 7620 is always so strongly marked; and also that the general brightness is lower in the second series than in the first, which might of course be due to a change of habit in the observer or to the use of a different instrument. If there be really a long period variation, its length is probably $16\frac{1}{3}$ periods, or 1151·5 days, judging by these figures.

The calculated curves A and C have been separately analysed, and the analysis of B has already been given. Expressed in the usual form, they are—

$$A = 30\cos(\theta - 173^\circ) + 27\cos(2\theta - 17^\circ) + 11\cos(3\theta - 226^\circ) + 4\cos(4\theta - 77^\circ)$$

$$C = 18\cos(\theta - 353^\circ) + 20\cos(2\theta - 13^\circ) + 6\cos(3\theta - 42^\circ) + 4\cos(4\theta - 72^\circ)$$

$$B = 23\cos(2\theta - 15^\circ) + 4\cos(4\theta - 74^\circ).$$

The phases are as in the shifted positions used for comparison. In the original positions of A and C, the phases in A are about 25° advanced, and those in C about 15° further back.

No. 18, R Serpentis 5677 Chandler

$15^h\ 44^m\ 1^s + 15^\circ\ 34'{\cdot}6$ (1855·0)
$15^h\ 46^m\ 5^s + 15^\circ\ 26'{\cdot}3$ (1900·0)

(A.S.V. Series II.: Harvard 1546 15).

Identification of Comparison Stars.—In this case one chart and sixteen small sketches of the comparison stars are extant, in which the designations given to them vary considerably, one star being called, at different times, *a*, *b*, *c*, and *d*, another *b*, *x*, and *d*, another *b* and *d*, another A and *a*, another A and *z*, and another *a* and *b*. This made their identification more difficult than usual, especially as the scales and orientation of the sketches vary greatly, and they are nearly all rough approximations, not drawn to scale.

TABLE VII.

Comparison Stars.

A Chart.	Baxendell. 1859. June.	1863. Apr. 23 and May 8.	1863. May 17.	1863. Aug. 17.	1864. May 7.	1865. Aug. 25.	1865. Sept. 7.	1866. Apr. 21.	1866. May 15.	1866. July.	1867. June 29.	1867. July 24.	1868. Apr. 9.	1868. May 11.	1868. July.	A. S. V. No.	A. S. V. Grade.	Harv. LVII. P. 247. Letter.	Harv. LVII. P. 247. Mag.	Adopted Mag.
z	...	...	...	...	...	...	...	...	...	...	...	...	...	A	...	2	8	*a*	6·78	69
a	...	...	...	...	...	...	...	...	*b*	...	*b*	...	...	...	...	4	81	*c*	7·48	75
7	...	...	A	A	*a*	*a*	*a*	*a*	*a*	*a*	*a*	*a*	*a*	*a*	*a*	3	81	*b*	7·44	74
b	*b*	*x*	*b*	...	*x*	...	*d*	*x*	...	...	...	...	...	...	...	7	88	*f*	9·25	92
c	...	...	*a*	*b*	...	*b*	*c*	*d*	...	*c*	...	*b*	*c*	...	*c*	5	84	*e*	8·40	84
d	...	...	...	...	*b*	...	...	...	...	...	...	...	...	...	...	6	86	*e′*	8·90	89
(Comp. *d*)	...	...	...	...	...	...	...	...	...	..	...	...	...	...	...	...	...	*f′*	9·80	98
e	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	..	...	...	...	?99
f	*f*	*y*	...	...	...	...	...	...	...	...	...	...	...	...	...	10	95	*h*	10·28	103
m	*m*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	9	91	*g*	10·04	100
x	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	116

In 1867 April, an *e*, *b*, and *f* are used which are said to be those of an "old chart," presumably older than the chart marked "A." But the only other chart which can be found has no letters on it at all except *β*. Neither chart is dated, but "A" chart is first mentioned 1878 May 30, after the long interval. It does not seem possible that the *b* and *e* of the observations of 1857 July can *both* be those of chart A, nor can those of 1867 April; but in all other cases they agree either with that chart or with a temporary diagram.

TABLE VIII.

Baxendell's Differences between his Comparison Stars.

Years.	74-69.	75-74.	84-74.	92-84.	103-92.
1857-9	$4\cdot7_{11}$	$2\cdot0_{12}$	$5\cdot5_{1}$	...	$10\cdot5_{1}$
1863-5	$5\cdot2_{14}$	$1\cdot6_{6}$	$15\cdot0_{5}$	$9\cdot7_{3}$	$10\cdot0_{2}$
1866-8	$5\cdot0_{8}$	...	$12\cdot4_{5}$	...	...
1878-81	...	$2\cdot0_{1}$	$9\cdot0_{2}$	$7\cdot3_{2}$	$7\cdot3_{3}$
Mean.	5·0	1·9	12·3	8·7	8·8
Number of Observations.	33	19	13	5	6
Reduced Mean.	4·3	1·8	9·8	7·2	7·5

The last two columns have too few observations to be of any real value. Baxendell notes on several occasions that *d* is double; and usually he calls the brighter component *d* and the fainter one "comp. *d*." But it seems almost certain that in 1857 August he used *d* to represent the combined brightness of the two component stars, as he makes it about equal to *c* in brightness, unless indeed *c* there represents a different star from the usual one, but there is no other instance of any other star being called *c*.

The telescopes used were A68 during the first series, and E80 during the second, with the following exceptions: C39 was used 1861, Mar. 19 and May 30; 1863, Feb. 14, Apr. 30, May 8 and 26, June 12, July 17 and 26, and Aug. 17; 1867, May 5. R(7)40; 1858, Mar. 16 to Apr. 30, June 13 and 21, and July 18. R(13)81; 1858, May. Tully 35; 1857, Sept. 22 to 1858, Mar. 6. A(30); 1857, Aug. 16 and 20, and 1858, Aug. 5. A(22)21; 1858, July 19, and Aug. 10 to 1859, Apr. 9. A(22)39; 1859, July 15. A21; 1858, July 1 to 17. A40; 1859, June 26 and 30. A60; 1861, May 27.

TABLE IX.

TABLE IX.

Baxendell's Observations of R Serpentis.

Date.	J. D.	Corrected Comparisons.	Deduced Mag.
1857	239+		
Apr. 26	9431	Invisible.	...
May 21	9456	,,	...
June 15	9481	Invisible.	...
July 25	9521	92+3, [?+3]*	?95
		98−3	
31	9527	98−3, [?−4]*	?95
Aug. 16	9543	?85+0†	?85
20	9547	74+4, ?85−3†	?80
22	9549	75+0, 74+3	?78
		?85−4†	
24	9551	74+2, 75+0	76
25	9552	74+2, 75+0	76
26	9553	74+2, 75+0	76
28	9555	74+0	74
Sept. 2	9560	74−1	73
7	9565	74−3, <69	71
12	9570	69+2, 74−4	70
16	9574	69+1, 74−3	70
19	9577	69+2, 74−3	71
22	9580	69+2, 74−3	71
25	9583	69+2, 74−2	72
28	9586	69+2, 74−2	72
Oct. 4	9592	69+2, 74−1	72
6	9594	69+3, 74+0	73
8	9596	69+3, 74+0	73
Nov. 1	9620	74+5, 75+4	79
1858			
Jan. 16	9696	Min. vis. −3	...
Feb. 17	9728	Invis.	...
Mar. 6	9745	,,	...
Mar. 16	9755	Invis.	...
26	9765	,,	...
Apr. 9	9779	Suspected.	...
20	9790	Invis. (sky not very clear).	...
May 1	9801	13 or 13·5 mag.; doubtful if R.	...
19	9819	13 or 13·5 mag.; doubtful if R.	...
June 13	9844	103+4	107
21	9852	Not seen.	...
July 1	9862	Invis.	...
10	9871	92+2	94
17	9878	92+0	92
18	9879	92−0	92
19	9880	92−1	91
30	9891	74+5, 84+0	82
Aug. 5	9897	74−1	73
6	9898	74−0	74
10	9902	69+2, 74−4	70
12	9904	74−4	70
21	9913	69−5, 74−7	66
Sept. 5	9928	69−6, 61+2	‡63
1859	240+		
Feb. 28	0104	Invis.	...
Apr. 6	0141	,,	...
9	0144	,,	...
June 26	0222	100+1, 103−2, 92+7	100

* The letter is *e*; if the first observation should be *e*−3, the *e* of chart A (99) may be meant.

† The letter is *d*, and comparisons with *c* suggest that the double is here used as one star, especially as a note on Aug. 25 says '*d* double.'

‡ 'P. xv. 206.'

TABLE IX.—*Baxendell's Observations of R Serpentis*—continued.

Date.	J. D.	Corrected Comparisons.	Deduced Mag.
1859	240+		
June 30	0226	92+5, 100−2	98
July 13	0239	92−4	88
15	0241	89+0 'Inter-	?89
		rupted by	
		cloud.'	
1861			
Mar. 19	0854	Invis.	...
Apr. 8	0874	,,	<13·0 ...
May 14	0910	Est.	10·5 ...
17	0913	,,	10·0 ...
27	0923	92+2 ,,	10·0 94
30	0926	92+2	94
June 14	0941	92+1	93
30	0957	74−2	72
July 26	0983	74−5	69
Aug. 30	1018	74−3	71
Sept. 20	1039	74+0	74
1862			
Sept. 10	1394	92−1	91
15	1399	92−2	90
20	1404	92−1	91
1863			
Feb. 14	1551	Invis.	<11·5 ...
Mar. 16	1581	,,	<13·0 ...
Apr. 13	1609	,,	<11·0 ...
23	1619	92+6, 103−7	97
30	1626	Not seen.	<10·0 ...
May 8	1634	92+3, 103−2	98
17	1643	84+4, 92−4	88
22	1648	74+6, 84−2	81
26	1652	74+10, 84−6	81
June 12	1669	74−2	72
20	1677	74−3	71
23	1680	74−3	71
30	1687	69+1, 74−4	70

Date.	J. D.	Corrected Comparisons.	Deduced Mag.
1863	240+		
July 3	1690	69+1, 74−3	70
17	1704	74−2	72
26	1713	69+3, 74−2	72
Aug. 17	1735	74+5, 84−7	78
29	1747	74+10, 84−3	82
1864			
Apr. 12	1974	Not seen.	<12·5 ...
May 7	1999	92−2	90
13	2005	89+3, 92−7	88
26	2018	74+6, 89−12	78
June 6	2029	74+2	76
July 4	2057	74−1	73
13	2066	74+2	76
1865			
Apr. 26	2353	74+1	75
May 1	2358	74−1	73
6	2363	74−1	73
15	2372	69+0, 74−5	69
18	2375	69+0, 74−5	69
20	2377	69−1, 74−5	68
24	2381	69−2, 74−6	68
June 8	2396	69−3, 74−6	67
10	2398	69−3, 74−6	67
17	2405	69−5, 74−7	66
20	2408	69−1, 74−6	68
21	2409	69−2, 74−6	68
July 1	2419	69−3, 74−6	67
13	2431	69+2, 74−3	71
19	2437	74−2	72
Aug. 3	2452	74+5	79
25	2474	74+11, *?84+0	?84
Sept. 7	2487	84+6, 92−4	89
1866			
Apr. 21	2713	92+2	94

* The letter is omitted in the comparison, but *b* is the only star in the sketch besides *a*, and it is the star called *c* in chart A.

TABLE IX.—*Baxendell's Observations of R Serpentis*—continued.

Date.	J. D. 240+	Corrected Comparisons.	Deduced Mag.
1866			
Apr. 23	2715	92 − 2	90
24	2716	92 − 2	90
May 7	2729	74+5, 84−7	78
15	2737	74+1, 75−1	74
17	2739	75+0	75
18	2740	74+0	74
20	2742	74+1, 75+0	75
22	2744	74+0	74
26	2748	74+2, 75+0	76
June 8	2761	74+0, 75−1	74
17	2770	74+1, 75−1	74
25	2778	74+1, 75+0	75
July 11	2794	74+6	80
16	2799	74+9, 84−1	83
Sept. 17	2862	below 11·5	...
1867			
Apr. 11	3068*	?89+0	?89
21	3078	†[?−2],†?92−8	?84
May 5	3092	74+1	75
11	3098	74−1	73
14	3101	74−2	72
21	3108	74−3	71
June 5	3123	74−1	73
29	3147	74+1	75
July 24	3172	84+0	84
1868			
Apr. 9	3432	74+11, 84+3	86

Date.	J. D. 240+	Corrected Comparisons.	Deduced Mag.
1869			
Apr. 11	3434	74+10, 84+1	84
May 11	3464	69+1, 74−4	70
20	3473	69+1, 74−4	70
30	3483	69+0, 74−3	70
June 4	3488	69+1, 74−3	70
7	3491	69+0, 74−4	70
16	3500	69+1, 74−3	70
19	3503	69+1, 74−3	70
25	3509	69+3, 74−1	72
29	3513	74+2	76
July 10	3524	74+4	78
23	3537	74+8, 84−2	82
1869			
Mar. 6	3763	Not seen <10	...
1878			
May 30	7135	75+3, 92−2	84
June 10	7146	92+0	92
23	7159	92+5, 103−2	99
28	7164	103+0	103
July 19	7185	103+11, ?116−2	?114
1879			
Mar. 31	7440	74+6, 84−3	80
1881			
May 7	8208	92+2, 103−4	96
8	8209	92+3, 103−3	98

These observations, when dealt with in the usual manner, with an assumed period of 357 days, give the following mean results.

The subscript figures give the number of periods in which observations occur.

Periods.	(1.)	(2.)	(3.)	(4.)	(5.)	(6.)	(7.)	(8.)	(9.)	(10.)	(11.)	(12.)
I. to V.	n.v.	n.v.	107_1	96_3	82_4	69_3	72_2	$76\frac{1}{22}$	...	...	...	n.v.
VI. to XII.	n.v.	n.v.	97_1	85_6	72_6	72_6	79_5	87_2	...	...	...	...
XXII. to XXV.	...	...	...	...	...	..	$80\frac{1}{21}$	...	96_2	$?114_1$	..	...

* "*f* of old chart"; probably *d* of chart A. † *e* and *b* of old chart.

Owing to the period being so nearly a year in length, to the impossibility of observing the star in this latitude during certain months, and to its being too faint when near minimum to be seen in Baxendell's instruments, the curve is very imperfect. But a retrograde movement of the epoch is evident between the first and second groups of periods, amounting to rather over half a "portion," say about 18 or 20 days. Allowance was made for this in deriving a mean curve, of which the only observed portion may be taken as

107 96 84 71 72 79 87 96

the first number corresponding to portion (3) for groups I. to V., and the maximum being 178 days after the adopted initial date.

The material being so scanty, the observations of the B.A.A. given in their diagrams (not the letterpress) were analysed by Miss Blagg. Taking all the observations together, a mean epoch 2417035 for E=80, combined with Baxendell's mean

Table X.

R Serpentis Comparison of Epochs.

	Bax. Period.	E	Observed Epoch.	Uniform.	O−U.	Chandler.	O−Ch.	New Formula.	O−NF.
			d.	d.	d.				
	I.	31	9582	9557	+25	9569	+13	9586	− 4
	V.	35	0990	0984	+ 6	0988	+ 2	0991	− 1
	VII.	37	1695	1697	− 2	1698	− 3	1693	+ 2
	VIII.	38	2046	2054	− 8	2053	− 7	2046	0
	IX.	39	2401	2411	−10	2408	− 7	2401	0
	X.	40	2756	2767	−11	2763	− 7	2758	− 2
	XI.	41	3119	3124	− 5	3118	+ 1	3117	+ 2
	XII.	42	3482	3481	+ 1	3473	+ 9	3478	+ 4
B.A.A. Observations.		75	5253	5252	+ 1	5274	−21	5255	− 2
		76	5619	5609	+10	5633	−14	5606	+13
		77	5961	5965	− 4	5993	−32	5957	+ 4
		79	6674	6679	− 5	6311	−37	6665	+ 9
		80	7036	7035	+ 1	7072	−36	7022	+14
		81	7393	7392	+ 1	7432	−39	7381	+12
		82	7752	7749	+ 3	7791	−39	7742	+10
		83	8104	8105	+ 1	8151	−47	8104	0
		84	8463	8462	+ 1	8510	−47	8466	− 3

epoch 2402054 for E=38, gives a mean period of 356·7 days. With what success this uniform period fits the observations is

shown in the above Table X. There are large residuals for E=31, 38, 39, 40, 76; but it seems possible that these are simply accidental.

Chandler's formula is

$$2388491+357{\cdot}2E+35\sin(4^{\circ}E+48^{\circ}).$$

The comparison of this with the observations shows that his formula as it stands is certainly not correct. From Baxendell's observations alone (*i.e.* before examining the B.A.A. observations) Miss Blagg derived the formula

$$2388514+356{\cdot}6E+20\sin(18E-78^{\circ})$$

which fits Baxendell's observations, but shows considerable deviations from those of the B.A.A.

The important question is whether the steady decrease of the residuals from E=31 to E=39 is due to the star or to some steady change in Baxendell's habits of observation. If they apply to the star, the period was at that time shorter by $4\frac{1}{2}$ days (35 days' change in 8 periods). But the hypothesis of their being observational errors seems at least as good as any other.

The first epoch, at E=31, is in any case very doubtful, as it follows closely on the beginning of Baxendell's observations of the star, and the identifications of the comparison stars for the first few observations are uncertain.

No. 19, *T Serpentis* (6624 *Chandler*).

h	m	s	°	′	
18	21	45	+6	12·5	(1855·0)
18	23	56	+6	14·0	(1900·0).

Identification of Comparison Stars.

In this case there is one chart, dated Aug. 30, 1884, and 15 small sketches, which vary considerably in the names given to the comparison stars, and are sometimes difficult to interpret, owing to differences in scale and orientation, a few comparison stars only being given each time. But it seems fairly clear that the identifications in Table XI. are correctly given.

TABLE XI.

TABLE XI.

Comparison Stars.

Chart.	Baxendell.															A. S. V.		Harvard.		Adopted
1884.	1806.	1867.		1880.	1881.	1882.			1883.	1884.				1885		No.	Grade.	Letter.	Mag.	Mag.
Aug. 30.	Nov. 9.	Sept. 5.	Oct. 3.	Apr. 17.	Apr. 23.	May 12.	May 19.	May 29.	July 28.	May 18.	June 25.	July 12.	July 19.	Aug. 11.	Aug. 14.					
76*a*														76*a*	76*a*	32	40	...	...	100
44														44	...	38	46	*d*	9·90	103
74														...	...	51	59	*e*	10·41	104
66														...	...	50	58	*k*	10·76	108
89														89	...	48	55	*g*	10·63	109
94														...	...	57	65	...	...	110
9														...	...	61	70	...	...	113
γ														...	...	67	73	*l*	11·22	112
95														*m*	..	73	78	*m*	11·47	115
91														91	...	74	78	..	...	117
76	...	...	*c*	...	...	*a*	*a*	...	*a*	...	...	...	...	96	...	72	76	*o*	11·85	119
a	...	...	...	*x*	*a*	*b*	*b*	*a*	*b*	*w*	*a*	*a*	*a*	*a*	*a*	88	93	...	...	122
c	2	Comp.	...	...	...	..	...	...	*c*	...	...	...	*c*	...	...	86	90	*t*	13·14	131
b	...	. .	. .	...	*b*	...	...	...	...	*x*	*b*	*b*	*b*	...	...	96	102	...	...	132
d	...	...	...	...	*c*	...	...	...	...	...	...	...	*d*	...	...	97	108	...	...	134
e	1	...	...	...	...	...	...	...	...	...	...	...	*e*	...	...	95	99	...	...	130
...									*d*	...	...	...	..	...	...					

TABLE XII.

Baxendell's Differences between his Comparison Stars.

Years.	103-100	108-103	108-100	104-100	109-108	115-109	117-115	119-117	119-115	122-119	132-122	112-108	115-112	115-113	115-108	113-108
1861-6 . .	$2\cdot8_9$	$\cdot4\cdot4_{14}$	$6\cdot8_9$	...	...	...	...	...	...	...	...	...	...	...	$4\cdot5_7$	...
1867-8 . .	$3\cdot2_3$	...	...	...	...	...	..	...	$5\cdot7_5$	...	...	$5\cdot8_6$	$1\cdot3_5$	...	$7\cdot6_6$	...
1880-3 . .	...	...	...	...	...	...	...	...	$6\cdot2_3$	$3\cdot5_3$	$8\cdot2_3$	...	...	...	$7\cdot0_1$	...
1884-6 . .	$4\cdot7_2$	$7\cdot7_3$	$10\cdot8_{13}$	$3\cdot2_{14}$	$3\cdot4_{13}$	$8\cdot8_6$	$2\cdot6_{11}$	$1\cdot8_8$	$5\cdot0_6$	$3\cdot9_4$	$8\cdot8_6$	...	...	$3\cdot4_4$	$13\cdot2_{12}$	$6\cdot1_5$
Mean . .	3·2	5·0	9·2	3·2	3·4	8·8	3·6	1·8	5·5	3·7	8·6	3·8	1·3	3·4	9·3	6·1
No. of Obsns. .	14	17	22	14	13	6	11	8	14	7	9	6	5	4	26	5
Reduced Mean	2·6	4·2	7·7	2·7	2·7	6·3	2·1	1·2	4·3	2·9	7·3	5·0	1·1	2·5	7·4	5·3

The unit is Baxendell's "step," converted to tenths of a magnitude in the "reduced mean," by applying the formula of reduction to each interval individually. The magnitudes adopted are those of Harvard (where those are available), except in the cases of 44 and 89, where the Harvard magnitudes do not suit the observed intervals.

There is, as usual, considerable variation in most of the intervals at different dates, and in four of the best observed comparisons the intervals increase with time, as is often the case in Baxendell's observations.

The telescopes used were A68 in the first series, and E80 in the second, with the following exceptions:—C39 was used 1861, April 29 and May 10; 1863, February 14 and May 25; R(13)81 was used 1861, May 3 to 9 and June 14; 1862, May 16; 1868, June 18 and July 27.

TABLE XIII.

Baxendell's Observations of T Serpentis.

Date.	J. D.	Corrected Comparisons.	Deduced Mag.
1861	240+		
Apr. 29	0895	108 – 2, 109 – 2	106
May 3	0899	103 + 1, 108 – 3	104
4	0900	103 + 1, 108 – 3	104
9	0905	100 + 3, 108 – 5, 103	
		103 – 1	
10	0906	Est. 105	
14	0910	100 + 2, 108 – 5, 103	
		103 + 0	
17	0913	100 + 2, 108 – 1, 104	
		103 + 1	
27	0923	100 + 3, 108 – 3, 104	
		103 + 2	
29	0925	100 + 2, 108 – 3, 104	
		103 + 2	
June 14	0941	100 + 4, 108 – 2, 105	
		103 + 2	
16	0943	100 + 4, 108 + 0, 106	
		103 + 3	
25	0952	100 + 9, 108 + 3, 111	
		103 + 6, 115 + 0	
30	0957	100 + 11, 108 + 6, 113	
		115 + 1, 103 + 8	
Aug. 30	1018	Invis.	<120
1862			
Apr. 29	1260	103 + 6, 108 + 0	108
May 16	1277	103 + 4, 108 + 0	108
31	1292	103 + 7, 108 + 3, 112	
		115 + 0	
June 28	1320	Invis. "Hazy."	
July 28	1350	,,	<130
Aug. 22	1375	"Not sure if glimpsed"	<133
Sept. 10	1394	Invis.	<130
Date.	J. D.	Corrected Comparisons.	Deduced Mag.
1862	240+		
Sept. 20	1404	? Glimpsed.	132
1863			
Feb. 14	1551	Invis. v. low.	<110
May 17	1643	108 + 5, 115 + 2	115
22	1648	108 + 6, 115 + 2	116
23	1649	108 + 5, 115 + 2	115
25	1651	Invis.	<117
June 20	1677	Glimpsed.	125
Sept. 5	1754	? Glimpsed.	<133
1864			
May 7	1999	,,	<130
26	2018	Not seen.	,,
July 4	2057	,,	,,
13	2066	Barely glsd.	132
29	2082	Not seen.	<132
Aug. 23	2107	,,	<130
Sept. 26	2141	,,	<132
Oct. 3	2148	,,	,,
1865			
May 18	2375	,,	<125
20	2377	,,	<133
24	2381	,,	<125
July 1	2419	,,	<132
Aug. 25	2474	,,	<133
Sept. 23	2503	,,	<127
Oct. 7	2517	,,	<125
1866			
Apr. 21	2713	,,	<110
May 15	2737	,,	<120
20	2742	,,	<130
24	2746	,,	<125

TABLE XIII.—*Baxendell's Observations of T Serpentis*—continued.

Date.	J. D.	Corrected Comparisons.	Deduced Mag.
1866	240+		
July 16	2799	Not seen.	<130
19	2802	,,	,,
31	2814	,,	,,
Aug. 27	2841	,,	<125
31	2845	,,	<130
Oct. 9	2884	Suspected.	132
Nov. 6	2912	Glpsd. 130−2	128
9	2915	130−3	127
30	2936	108+2, 115−3, 112 113+1	
1867			
June 29	3147	Not seen.	<130
July 24	3172	,,	<133
Sept. 5	3215	Glpsd. 130+3 ?133	
25	3235	131−2	129
Oct. 3	3243	131−6, 119+2	123
Nov. 1	3272	108+7, 115−2, 114 119−4	
19	3290	100+1, 103−2	101
Dec. 6	3307	100+3, 103+0	103
12	3313	100+4, 103+1	104
1868			
May 20	3473	Invis.	<133
June 18	3502	,,	<135
July 21	3535	,,	<132
23	3537	,,	,,
27	3541	,,	<135
Sept. 4	3580	,,	<120
6	3582	,,	<125
21	3597	,,	<110
Oct. 7	3613	108+7, 115+1, 115 112+3	
17	3623	108+3, 115−3, 111 112−3, 119−8	
19	3625	108+3, 115−3, 110 112−3, 119−9	

Date.	J. D.	Corrected Comparisons.	Deduced Mag.
1868	240+		
Oct. 27	3633	108+1, 115−5	110
Nov. 5	3642	108+2, 112−2, 110 115−5, 119−8	
15	3652	108+2, 115−5, 110 112−3, 119−9	
1878			
July 7	7173	Invis.	<135
25	7191	,,	,,
Aug. 25	7222	,,	,,
Oct. 26	7284	,,	,,
1879			
Aug. 8	7570	,,	,,
11	7573	,,	<130
1880			
Mar. 17	7792	115−1	114
18	7793	108+6, 118+0, 115 119−4	
Apr. 1	7807	115+4, 119−1	118
11	7817	115+10, 119+5 min. vis. −8	124
1881			
Apr. 17	7823	122+0	122
30	7836	131+0	131
Apr. 23	8194	122+4, 132−4, 134−7	127
May 4	8205	122+3, 132−3	127
7	8208	122+5, 132−2	128
16	8217	132+1	133
20	8221	min. vis. −3	
1882			
May 12	8578	119+3, 122−2	121
19	8585	119+2, 122−0	122
29	8595	Suspected <119+6	

TABLE XIII.—*Baxendell's Observations of T Serpentis*—continued.

Date.	J. D.	Corrected Comparisons.	Deduced Mag.
1883	240+		
July 28	9020	?119+3, ?122+1	?
* ?	?	?119+0	?
Aug. 25	9048	?119+2,?	−4 ?
1884			
May 18	9315	132+1	133
19	9316	132+0	132
26	9323	132−2	130
27	9324	132−3	129
June 14	9342	122+4, 132−4	127
25	9353	122+6, 132−4	128
July 12	9370	122+6, 132−2	129
19	9377	122+0	122
25	9383	122−2, 132−6	123
27	9385	122−3	119
Aug. 11	9400	117−1, 122−10, 113 119−8	
14	9403	117−6, 115−3, 111 119−9, 122−11	
15	9404	117−3, 119−2	116
16	9405	117−5, 119−6	112
18	9407	117−6, 119−6, 112 115−3	
19	9408	115−4, 117−7, 111 119−7	
22	9411	115−4, 117−6	111
23	9412	117−8, 119−9, 110 115−7, 108+6	
25	9414	108+6, 117−7, 111 115−5	
Sept. 1	9421	108+3, 113−4, 108 115−9, 117−11	
2	9422	103+6, 115−9, 109 108+3	

Date.	J. D.	Corrected Comparisons.	Deduced Mag.
1884	240+		
Sept. 11	9431	108−2, 100+10, 106 115−9, 117−11, 109−2, 113−9	
12	9432	108−1, 117−11 106 100+7, 115−10, 109−3, 113−8	
13	9433	100+7, 109−4, 106 115−11, 108+0	
17	9437	100+6, 108−3, 104 109−6, 115−12	
20	9440	100+6, 108−3, 104 109−7, 115−13	
26	9446	100+6, 108−3	106
Oct. 5	9455	100+3, 108−6	102
9	9459	100+3, 108−8, 100 109−11	
12	9462	100+2, 108−8, 100 103−3, 109−10	
28	9478	100+8, 108−3	106
Nov. 7	9488	103+6, 109−2, 107 108−5, 105+2, 110−1	
17	9498	108+5, 117−4, 111 115−5, 109+0	
19	9500	108+8, 117−6, 112 109+1	
Dec. 8	9519	131−4	127
1885			
May 7	9669	122+3, 132−3	127
11	9673	122+3, 132−4	126
20	9682	122−2	120
June 9	9702	122+4	126
July 4	9727	122+3, 131−3	126

* It is uncertain whether this obsn. was made July 28, or on a later day and the date omitted. Bax. writes: "The v. faint companion is n. p. a more distant and brighter companion at *c*"; and he adds a note, dated Aug. 29/84, "The v. faint comp. is the real T and is 13 mag." These comparisons appear therefore to have been made, not with T, but with one of the comparison stars.

TABLE XIII.—*Baxendell's Observations of T Serpentis*—continued.

Date.	J. D.	Corrected Comparisons.	Deduced Mag.
1885	240+		
Aug. 1	9755	122+1	123
3	9757	122−4	118
14	9768	122−8, 115+0,	114
		119−7, 108+8	
Sept. 3	9788	100+7, 109−3,	107
		104+3, 103+4	
13	9798	100+3, 109−7,	104
		104+1, 108−1	
1885	240+		
Sept. 27	9812	100+7, 109−3,	106
		104+1, 108−2	
Oct. 29	9844	119−3, 115+0,	115
		117−3	
1886	241+		
Sept. 17	0167	100+8, 109−2,	108
		104+3, 108+1	
Oct. 25	0205	119+2, 122−4	120

Chandler's period for this variable was 342·3d. in his 3rd catalogue, and 341·8d. in his revision; but, before these had been looked up, a period of 342 days had been assumed, independently, from Baxendell's observations alone. These, when dealt with in the usual manner, give the following means for 4 groups of periods.

	(1.)	(2.)	(3.)	(4.)	(5.)	(6.)	(7.)	(8.)	(9.)	(10.)	(11.)	(12.)
A	...	...	...	104	106	112	...	...	...	...	...	...
B	133?	127	117	106	107	...	...	...	...	...	(132)	(127)
C	...	...	...	...	...	116	126	(128)	(127)	(<123)	...	...
D	126	121	114	104	107	116	120	...	...	...	...	...
Mean	128	123	116	105	107	114	123	[Untrustworthy.]				

Group A contains periods I. to III.; B, periods VII. to IX.; C, periods XXI. to XXIII.; and D, periods XXV. to XXVIII.

In this case, again, Baxendell could not see the star when near its minimum, especially with the instruments used in the earlier series; and as the period does not differ much from a year, and the star's position prevented his observing it during certain months, it was never clearly visible to him at all during periods iv. to vi.—from 1863 May 25, to 1866 October. The curve is thus very incomplete in the first series, portions 7 to 1 having no clearly seen observations; and, in the second, portions 9 to 11 have only 2 observations each. The curve is therefore too uncertain to be used with advantage for obtaining corrections to epoch, and the means for groups of periods given above do not suggest any such corrections; so that the assumed period of 342 days may be said to suit these observations well, except perhaps in regard to period IX., where the maximum has either not been reached by the normal date, or is fainter than usual. The date of maximum, read from the observed part of the curve, is at about 111 days after the initial date of the period, which

would give the following epochs for the periods observed (in part) by Baxendell.

Period.	Epoch.	Period.	Epoch.
	240+		240+
I.	0911	XXI.	(7751)
II.	(1253)	XXII.	(8093)
III.	(1595)	XXIII.	(8435)
VII.	(2963)	XXV.	(9119)
VIII.	3305	XXVI.	9461
IX.	3647	XXVII.	9803
		XXVIII.	(10145)

The epochs in brackets are those the dates of which were either earlier than the commencement, or later than the conclusion, of a series of observations. The remaining epochs are all compatible with the observations, with the possible exception (as already mentioned) of period IX.